UNIVERSITY OF LONDON
FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS. I.

THE INHERITANCE OF ABILITY,

BEING A STATISTICAL STUDY OF THE OXFORD CLASS LISTS AND OF THE SCHOOL LISTS OF HARROW AND CHARTERHOUSE.

BY

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THE FRANCIS GALTON EUGENIC LABORATORY.

University of London, University College, Gower Street, W.C.

[The temporary address of the Laboratory is 88, Gower Street, W.C.]

The Laboratory is under the supervision of Professor Karl Pearson, F.R.S., in consultation with Mr Francis Galton, F.R.S.

Francis Galton Fellow in National Eugenics: David Heron, M.A.

Francis Galton Scholar: Miss E. M. Elderton.

Computer: Miss Amy Barrington.

Advisory Committee.—The following have kindly consented to aid the Staff of the Laboratory in special forms of enquiry:—

W. Palin Elderton.	E. Nettleship.
J. Macpherson, M.D.	Edgar Schuster, M.A.
F. Mott, M.D., F.R.S.	Lieut.-Colonel R. J. Simpson, R.A.M.C.

J. F. Tocher.

National Eugenics is the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally.

It is the intention of the Founder, Mr Francis Galton, that the Laboratory shall act (i) as a storehouse for statistical material bearing on the mental and physical conditions in man and the relation of these conditions to inheritance and environment, (ii) as a centre for the publication or other form of distribution of information concerning National Eugenics. Provision is made in association with the Biometric Laboratory at University College for training in Statistical Method and for assisting research workers in special Eugenic Problems.

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V. II

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Some reconstruction of the Francis Galton Laboratory having taken place, it seemed desirable to provide the workers associated with it with a direct channel of publication of their own, in which their more extended memoirs should appear. It is hoped that the present series may be issued at short intervals. Subscribers should notify their intention of taking in the memoirs as they are published to Messrs Dulau & Co. Requests to exchange with similar publications, with archives and journals dealing with demographic and sociological problems, or with census reports should be directed to The Editor, Eugenics Laboratory, University College, Gower Street, London, W.C.

Science

CONTENTS

In the Appendix Professor Pearson deals with an important factor tending to modify our results, the consideration of which is omitted from the body of the Memoir. With the views which he expresses we are entirely in agreement.

INTRODUCTION.

At the time of the first publication of Mr Galton's *Hereditary Genius*, in 1869, the belief in the hereditary nature of inborn natural ability was held by very few; but so great has been the influence of that and other works that at the present time it would be almost impossible to find an educated person to dispute it, and the inheritance of psychical characters ranks with motor-cars and the morphia habit among the ingredients in the composition of the contemporary novel.

With the diffusion of an idea it becomes progressively more vague and indefinite, so that an attempt to give it crispness of outline becomes all the more desirable, and for this purpose one must substitute, for a description that is merely qualitative, one that is also quantitative, and, having recognized the pressure and direction of a force, one must endeavour to measure it.

Such a description of the inheritance of the mental and moral qualities has been given by Professor Pearson in his Huxley Lecture before the Anthropological Institute, and it has been our endeavour to confirm and supplement his results with others obtained from different material treated at the outset in a fundamentally different way.

The essential difference between his results and ours is that the former are based on the estimates of the school teachers of the ability of pairs of brothers, or sisters, or brothers and sisters, while we have used the results of the examinations for the B.A. degree at Oxford, the position in the school of boys in the school at definite times in their life or in their school career. This has enabled us with regard to the Oxford material to measure the average resemblance between father and son, as well as that between brother and brother, and we shall endeavour to show that, after certain allowances have been made, our results are substantially in agreement, not only with those of Professor Pearson, which are referred to above, but also with other work on more easily measurable characters.

Perhaps it would be as well to define, as exactly and as simply as we can, the meaning we attach to the phrase "measure the average resemblance between father and son." We know that the intelligence of the fathers varies very much and so also does that of the sons; we know in a general sort of way that the sons of those fathers who are above the average of fathers, are themselves on the whole more intelligent than the average of sons; if we take a group of fathers,

each of whose intelligence is the same definite amount, which we will call A*, above the average, their sons will form a group which varies considerably, but whose average intelligence is a certain definite amount, which we will call B*, above that of all the sons of all the fathers.

We presume, and there is considerable reason for the presumption, that whatever be the magnitude of A the relation of B to A, that is to say the value of the fraction B is, within certain limits, the same, and we want to find out exactly what it is. When we have found it we shall have measured the average resemblance between father and son, for if the resemblance be complete and perfect then the value of this fraction would be 1, for B would be equal to A, that is to say that the sons of any particular group of fathers of given intelligence will differ from the average of all the sons by exactly the same amount as the intelligence of their fathers differed from the average intelligence of all the fathers. If there be no resemblance the value of the fraction is 0, and every intermediate value between 1 and 0 expresses a different degree of resemblance.

A statistical statement of the effect of inheritance on the mass such as is attempted here is quite independent of what view is taken of the truth of Mendel's laws and whether they be universal in their application or not; this fact has been frequently insisted upon, yet it seems desirable to do so once again. Even if we believe in the universal applicability of these laws—and it cannot be claimed that this has as yet been proved—they would tell us nothing concerning the inheritance of inborn ability until such a time as some general law of dominance has been discovered and some better definition of a unit character evolved than that which is at present accepted—namely a character that is inherited according to these laws. Furthermore, granting that this time had come, Mendel still would tell one nothing unless in each case both parents were known, and through a necessary limitation of the material this condition does not obtain. Enough has been said to show to any but the extremists of the Mendelian school that this work, if properly executed, is of value, and that if this is not the case the blame must be attached to the authors personally, and not to the methods which they employ nor to the school to which they belong.

* For the sake of simplicity we have omitted to state in the text that A is measured in terms of the standard deviation of fathers, and B in terms of the standard deviation of the sons.

PART I.

THE EVIDENCE OF THE OXFORD CLASS LISTS.

A. *Sources of Material.*

THE standard biographical works concerning past and present members of Oxford University are Foster's *Alumni Oxonienses* and its continuation *Oxford Men and their Colleges*. The former is divided into two parts, each consisting of four octavo volumes—an earlier one covering the years 1500—1714, and a later one, which deals with those who entered the University between 1715 and 1886, while the continuation brings the information up to 1892. Since the Oxford honours examinations on which our tables are largely based were only instituted in 1800, only a portion of the later part could be employed, but it will be seen that in spite of this an ample amount of material has been obtained.

The biographical notice of each member of the University gives, among other information, the name of his father and the name of the college to which he belonged; it tells whether or no he took the B.A. degree, and if so at what date. Thus from this we were enabled to find the relationship between a large number of pairs of fathers and sons, and of a large number of families of brothers, while the remaining information which we required, namely the class obtained in the case of an honours degree, was supplied by the *Oxford Historical Register*. The last-named work contains among other useful features an alphabetical register of all those who obtained honours or distinctions at the University between 1220 and 1900; after each name is given the college to which he belonged, which is useful for purposes of identification, and a dated list of the honours and distinctions obtained. Thus the labour of finding out which class, if any, was obtained by each of the several thousand persons included in our tables was reduced to a minimum. The history of the honours examinations at Oxford, which may be found summarized on p. 191 of the *Historical Register*, stated still more briefly, is as follows: From 1800—1806 the honours examination was conducted separately to the pass examination, the candidates were examined both in classics and mathematics, and there were two classes of honours, but during those years, either very few people entered for honours, or the standard was exceedingly high, for only 14 men appear in either the first or second class. From 1807—1830 alternative subjects were introduced, namely *Literae Humaniores* or classics, and *Disciplinae Mathematicae et Physicae* or mathematics; all candidates, whether

for honours or no, were examined together, and there were in 1807—8 two classes of honours, which were increased to three in 1809. In 1830 an extra class was added and those who were not candidates for honours were examined separately from those who were, but permission was given to the examiners to include in the fourth class honours list those candidates for the pass degree whom they thought worthy of it. This enactment came to an end in 1865, when the honours examination and pass examination were allotted to different bodies of examiners. From 1830 onwards the four classes of honours have remained the same, although the number of subjects in which the examination is held has been greatly increased.

Up to the year 1834 the members of New College were exempt from the University examinations, a privilege which shut out that college from the "rapid improvement in industry and intellectual vitality which that measure brought with it for the best of Oxford colleges." At that date it was voluntarily renounced by the college, but up to then New College men can hardly be considered to have been members of the University as far as examinations are concerned and are therefore not included in the tables which we have made.

B. *The Resemblance between Father and Son.*

The first step in the process of tabulation was to divide the men into three classes according to the date at which they took, or should have taken their degrees, the limits of the three groups being as follows: 1800—30, 1830—60, 1860—92. We will consider the latest of these first, namely the group 1860—92, and deal only with those men whose fathers were educated at Oxford. They were found to consist of 2459 persons, of whom 149 had been placed in the first class, 329 in the second, 377 in the third, 190 in the fourth; of whom 868 had taken merely a pass degree, and 546 had failed for one reason or another to take any degree at all. Each of these six classes was sorted again according to the degree taken by the father; of the 149 first class men, 27 had fathers in the first class, 27 in the second class, 14 in the third class, 13 in the fourth, and 53 with pass degrees and 15 without degrees; of the 329 second class men, 52 had fathers in the first class, 54 in the second class, 33 in the third class, 30 in the fourth class, 138 with pass degrees, and 22 with no degrees; of the 377 third class men, 47 had fathers in the first class, 64 in the second, 47 in the third, 42 in the fourth, 157 with pass degrees, and 20 with no degrees; of the 190 fourth class men, 20 had fathers in the first class, 27 in the second class, 22 in the third class, 17 in the fourth, 91 with pass degrees, and 13 without degrees; of the 868 men who took pass degrees, 41 had fathers in the first class, 79 in the second, 95 in the third, 87 in the fourth, 479 with pass degrees, and 87 with

no degrees; of the 546 who took no degrees, 31 had fathers in the first class, 39 in the second class, 46 in the third class, 52 in the fourth, 277 with pass degrees, and 101 with no degrees. These results will be found stated in a less distressing way in Table I A., but at the risk of seeming, or possibly it might be more accurate to say, in spite of the certainty of being insufferably tedious, we have repeated them in words here, so that those people who are quite unfamiliar with this class of table should have no difficulty of apprehending its meaning.

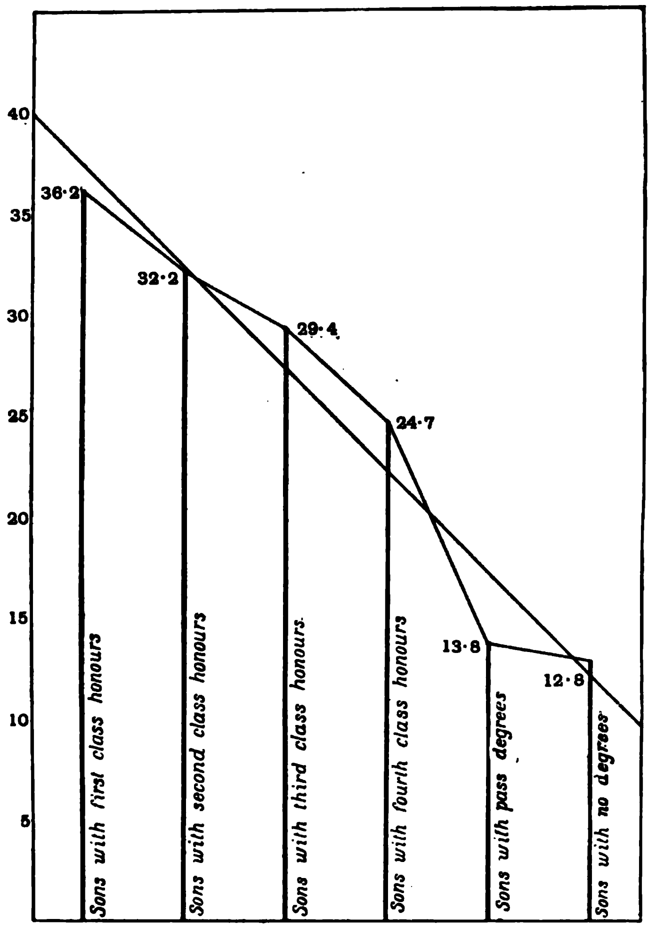

DIAGRAM I. (date of degree of sons, 1860—92).

The heights of the vertical lines show in what percentage of cases the fathers have taken either first class or second class honours. The diagram is intended to show that the percentage of fathers who obtained this degree of distinction diminishes with some regularity, as one passes downwards from the sons with first class honours to those with no degrees.

Even without any mathematical treatment we can learn a great deal concerning heredity from it. Thus it will be seen from Table I B. that of the fathers of the first class men 36·2 per cent. obtained either a first or a second class themselves, and thus were on the whole slightly superior to those of the second class men of whom only 32·2 per cent. reached this standard; a stage lower is reached in the fathers of the third class men, among whom the percentage of first and second

class men has sunk to 29·4, and the percentage becomes progressively lower as we go to the lower classes; thus it is 24·7 among the fathers of the fourth class men, 13·8 among those of the pass men and 12·8 in those of the no degree class.

The two points to be noticed about these figures are firstly that the percentage of first and second class fathers diminishes as one passes down through the various classes of sons, and secondly that it does so in a very orderly way. In order to show both these points quite clearly Diagram I. has been constructed. In this diagram the height of the six vertical lines is proportional to the percentage of fathers in the first or second class of each of the six groups of sons respectively. The upper end of the left hand upright, which represents this percentage among the fathers of first class sons, and the upper ends of the five other uprights, which indicate the same fact concerning the fathers of the five other classes of sons, lie almost on a straight line, shown in the diagram, which slopes down steeply from left to right, making an angle of 45 degrees approximately with the horizontal.

One more fact must be referred to concerning Table I A. before leaving it for a time to consider Table II A. It may give the impression that exactly the same number of fathers are included in it as sons; that is to say that it deals with only one son of each 2459 fathers; but this is not the case. 2459 men of the younger generation are included, but as in some cases two or three or even more of these are sons of the same father he may be included two or three or even more times, being counted once over for each of his sons that are dealt with in the table.

We will now pass on to the consideration of Table II A., which has been constructed in exactly the same way as Table I A., but out of entirely independent material, for in this case all the sons took their degrees or should have taken them prior to 1860, but since no fathers prior to 1800 could be included it happens that almost all the sons took their degrees between 1830—1860, and all the fathers between 1800—1830.

As will be remembered the fourth class of honours was not introduced till 1830, so that those fathers who took honours are only divided into three classes. If we examine this table in the same way as we have examined the previous one we shall find a remarkable agreement, for 41·9 per cent. of the sons in the first class had fathers in either the first or second class, and the percentages of the remainder whose fathers achieved this distinction are as follows: 40·7 per cent. of the second class, 33·3 per cent. of the third, 28·1 per cent. of the fourth, 20·1 per cent. of the pass degree men, and 12·9 per cent. of those who took no degree. These numbers are shown graphically in Diagram II. As in Diagram I. the upper ends of the vertical lines which represent the percentages lie almost on a straight line which slopes steeply downwards from left to right.

Enough has now been said to show not only that signs of hereditary influences are well marked, but—although nothing certain can be predicted in individual cases—there is a considerable regularity when we deal with large numbers, a regularity which becomes more marked as the numbers are increased. However we proposed to go further than this and make a definite measure of the intensity of this force, and we will now go on to describe the results of this attempt.

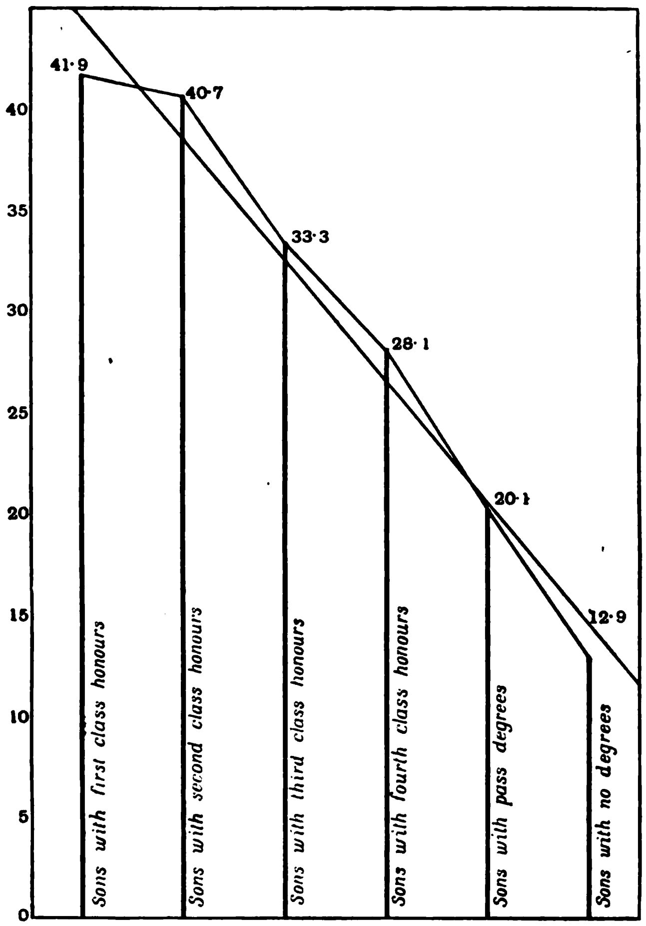

DIAGRAM II. (date of degree of sons, 1830—60).

The heights of the vertical lines show in what percentage of cases the fathers have taken either first class or second class honours. The diagram is intended to show that the percentage of fathers who obtained this degree of distinction diminishes with some regularity, as one passes downwards from the sons with first class honours to those with no degree.

Two methods have been used in doing this, namely that of "Contingency" and that of "Fourfold Correlation." The former of these will be found in the paper by Professor Karl Pearson "On the Theory of Contingency and its relation to Association and Normal Correlation," which forms No. 1 of the Biometric Series of the *Drapers' Company Research Memoirs*, published by Dulau and Co. in 1904. The latter will be found fully described in the paper by the same author "On the Correlation of Characters not quantitatively measurable" (*Phil. Trans.*

Vol. cxcv. A. pp. 1—47). It will be interesting to see how far the results obtained by the two methods used are in accordance with one another. With regard to the first named or "Contingency" method two slightly different variations of it are employed, the result of one of these, called "the Mean Square Contingency Coefficient," and represented by the symbol C_1, was found for Table I A. to be ·26, while for Table II A. it was ·29. The result of the other, called "the Mean Contingency Coefficient," and represented by the symbol C_2, gave ·29 for Table I A. and ·31 for Table II A.

In order to obtain the correlation coefficients by the fourfold method from Tables I A. and II A. it is necessary to reduce these tables to their simplest form. As this simplification can be done in many slightly different ways, slightly different values of the correlation coefficient may be found. Thus Tables I B., I C., and I D. are simplifications of Table I A. Table I B. tells one that of the 2459 sons, 478 obtained honours in classes I. and II.; whereas 1981 were placed in the third or fourth classes or obtained either a pass degree or no degree; and that of the 478, 160 had fathers of equal distinction to themselves and 318 who were inferior to them, having merely obtained third or fourth classes or pass degrees, or having obtained no degree at all; of the 1981 composing the inferior class of sons, 348 had fathers in the upper class and 1633 in the lower.

From this table the correlation coefficient, for which the symbol Υ is used, was calculated and found to be ·29. Table I C. was made in exactly the same way as I B. except that the division between the sheep and the goats was made below the third class instead of below the second, so the former category is larger than in the previous case, both with regard to the fathers and to the sons; it is unnecessary to repeat the numbers here, as they are set out in the table in question. The correlation coefficient calculated from this table = ·31. In making Table I D. the same process was repeated except that all those who obtained honours were separated from all those who did not do so. The value of the correlation coefficient obtained was ·28. Thus it will be seen that the value of this coefficient is in this case very much the same whether the division between the upper and lower groups of fathers and between the upper and lower groups of sons, is made beneath the second class, the third class, or the fourth class. The mean of the three values obtained is ·293.

Tables II B. and II C. correspond with Tables I B. and I C. and are made from the earlier material classified in Table II A. in precisely the same way as these tables are made from the more modern material included in Table I A. The correlation coefficients obtained from them are ·34 and ·33 respectively, the mean of which is ·335, a somewhat higher value than the ·293 mentioned above.

Table III. summarizes all the coefficients calculated hitherto; it shows the degree of similarity in the results which may be expected in treating two quite independent sets of material each by three different methods. Thus if we consider

unity to be the measure of perfect resemblance and nothing of no resemblance, by disregarding minor differences and speaking somewhat broadly, we may say that degree of intellectual similarity between father and son, as indicated by the degrees which each took, is ·3 or nearly $\frac{1}{3}$.

C. *Resemblance between Brother and Brother.*

We will now pass on to the consideration of fraternal resemblance. In Table IV A. the material used consisted of those families of brothers in which the majority of the brothers took their degrees between the years 1860—1892; it is constructed much on the same principle as Tables I A. and II A., except that instead of considering each son in relation to his father, every man included is considered in relation to each of his brothers taken in turn. Thus in dealing with a family of two brothers, X and Y, who may have taken a first and a fourth class respectively, in the first place X is taken and is entered in the fourth square from the left of the top row as being a first class man with a fourth class brother, and then Y is entered in the left hand square of the fourth row as being a fourth class man with a first class brother, so that each family of two contributed two to the total number of 4266 pairs. Now let us consider a family of three brothers, X, Y and Z, who were placed respectively in the first, second and third classes; X is in this case entered twice—once in the second square from the left of the top row, as being a first class man with a second class brother, and once in the third square of the same row as having a third class brother; but if both Y and Z had been in the second class he would have been entered twice in the second square. Similarly Y is entered once in the left hand square and once in the third square of the second row, and Z is entered once in the left hand square and once in the second square of the third row. Thus the family of three contributes $3 \times 2 = 6$ to the total number, a family of four, $4 \times 3 = 12$, of five, $5 \times 4 = 20$, and so on; so that the total 4266 does not represent 8532 men taken together two by two as might possibly have been supposed, but 4266 pairs made from a smaller number of men. It will be noticed as a result of this method of construction, the table is symmetrical about an axis which runs from the left hand top corner to the right hand bottom corner.

If to begin with we examine this table in the same way in which the examination of Tables I A. and II A. was begun, we shall see that out of the 339 first class men reckoned in the way described above, 154 or 45·5 per cent. had brothers in the first and second classes; of the 668 second class men, 254 or 38 per cent. had brothers attaining this standard; and that the percentages diminish steadily and fairly rapidly as we pass down our scale of classes to 27·6 per cent. for the third class men, 21·2 per cent. for the fourth class men, 15·3 per cent. for the pass

men and 12·6 per cent. for those who obtained no degrees. If we compare this series with the corresponding one obtained from Table I A. we shall see a well-marked general similarity between the two, but, although the percentage of first and second classes among the brothers of the men who failed to take degrees is practically identical with that among the fathers, it is considerably higher among the brothers than among the fathers of first class men; so that we can conclude from this alone that the resemblance between brother and brother is more marked than that between father and son; and it will be seen when we come to treat the contingency and correlation coefficients that the same result is obtained from them also.

It will be unnecessary to consider separately the Tables V A. and VI A.; the former is made from those families in which the majority of brothers took their degrees between 1830 and 1860, and in the latter those between 1800—1830 were used; a few individual brothers in this case did actually take their degrees later than 1830 and thus were capable of obtaining fourth class honours, but very few were so placed, and as the number of these was so small, in making the table it was not thought worth while to treat them separately and they were included among the pass degree men.

For all the three sets of material included in Tables IV A., V A. and VI A. respectively, the mean square contingency coefficient and the mean contingency coefficient were calculated, and in order to obtain various values for the correlation coefficient the original tables were simplified in different ways. Thus in constructing Tables IV B., V B., and VI B., divisions both vertical and horizontal were made in IV A., V A., and VI A., between the second and third classes and all the numbers in each of the four divisions of these tables thus defined were added together; to make Tables IV C., V C., and VI C. the original tables were divided between the third and fourth classes; and Tables IV D. and V D. were made by simply separating honours men from the rest. The results of all these variations in method are summarized in Table VII. From this it will be seen that all the correlation coefficients agree tolerably well together, and all the mean square contingency coefficients agree together exceedingly well, but that the latter do not agree with the former, being in each case considerably less, and it will be remembered that a difference in the same direction but not nearly so well marked was noticed with regard to the tables dealing with the fathers and sons, the results of which are summarized in Table III.

D. *The Influence of Family Traditions on the Results obtained.*

The differences that are pointed out in the preceding paragraph between the mean square contingency coefficients and the correlation coefficients are probably due to the fact that the material is not homogeneous, that is to say that each

table is in reality made up of two groups of men, whose success in the examination is determined by two different sets of circumstances. The first and probably the larger of the groups consists of those men who were really placed according to their merits, and consists of all those who tried for honours, whether they obtained them or not, together with those who refrained from trying because it was recognized by themselves or their tutors that they were not up to the honours standard. The other group consists of such men as did not try for honours although of sufficient intellectual capacity. As family circumstances or family tradition influence a man when he decides for what kind of degree he shall become a candidate, in that he is more likely only to aim at a pass if his father or elder brother should have done so before him, we shall get an excess of pairs of fathers and sons or brothers and brothers who have each taken pass degrees, beyond what might normally have been expected, if every man were classed entirely on his own merits. The effect of this excess is to increase the size of the correlation coefficients and thus to give a greater appearance of inheritance of ability than would be manifested if it were not present, also to spoil the agreement between the contingency coefficients and the correlation coefficients.

The difference between these two is greater in the tables dealing with resemblance between brother and brother than in those dealing with that between father and son, so that we may conclude that the example of his brother has more influence on a man's choice whether or no he shall try for honours than that of his father, or at any rate that there are more common circumstances influencing the choice of each of a pair of brothers than of a father and his sons. This conclusion is in accordance with one's personal experience and we shall adduce other arguments to support it.

If in making the tables we could have separated the two groups of men distinguished above, the consideration of the question would have been greatly simplified. Unfortunately it was impossible to do this, but in order to obtain a rough idea of the influence of family tradition on our results the following test has been applied to our tables. A vertical strip consisting of the three right-hand columns* of Tables I A. and V A., and of the two right-hand columns of Tables II A., IV A., and VI A., was cut off in each case, thus leaving in the tables only those pairs of which one member at least tried for honours. In this way the possibility of including any man in the tables who took a pass degree merely because—in the case of Tables I A. and II A.—his father did, or—in the case of Tables IV A., V A., and VI A.—because his brother did, is entirely eliminated. Fourfold correlation tables were then constructed out of the portions of the tables that were left, and the results for each table were as follows:

* It was necessary to remove the fourth class column, because these fourth classes were obtained during a period in which a regulation was enforced allowing the Examiners to place in the fourth class of honours any candidate for a pass degree, who was considered worthy of honours.

Table I A., after the three right-hand columns had been removed from it, which contain all the sons who had fathers in the fourth class or who had taken pass degrees or no degrees, gave a mean value for the correlation coefficient of ·245, a result derived from fourfold tables made in two different ways. The fathers were in both cases divided into two groups, the one containing the first and second classes, the other the third class, and the sons being in the one case divided into two groups by a line drawn below the second class and in the other below the third class. It will be remembered that the original mean value obtained for the correlation coefficient was ·290.

From Table II A. the two right-hand columns were removed which contained those sons whose fathers had taken pass degrees or no degrees. From what was left fourfold tables were constructed in two different ways; in both cases the fathers were divided into two groups containing on the one hand the first class, and on the other the second and third classes, and the sons were divided in the first table by a line drawn below the third class and in the second below the fourth. The mean value of the two correlation coefficients was ·200, as against ·335 obtained from the original table.

The three tables IV A., V A., and VI A. dealing with fraternal correlation were treated in an analogous way and gave mean values for the correlation coefficients of ·235, ·175 and ·255 respectively, as against ·393, ·397 and ·425 obtained from the original tables. Thus it will be seen that the process applied brings about a great reduction in the value of the correlation coefficients, and that this reduction is more conspicuous in the tables dealing with brother and brother than in those dealing with father and son. It is the latter circumstance which confirms our conclusion stated previously that tradition and other external causes are more potent in magnifying the appearance of heredity in the fraternal groups than in the paternal.

It must not be supposed that the reduced values are to be regarded as the true measures of the intensity of the purely hereditary influence, after an allowance has been made to counteract that of tradition, because even if the latter had been absent altogether in the first instance the effect of cutting off strips from the correlation table would have had the effect of reducing the value of the coefficients. But the process adopted does show that, after making an allowance for tradition which certainly very much *more* than counteracts it, it is still possible to detect a very considerable hereditary influence.

In order to give further support to the contention that the method of correction employed gives a greatly *exaggerated* estimate of how much of our results are due merely to tradition, let us turn for a moment to Table V D., which deals with those pairs of brothers who took their degrees between the years 1830—1860, in which the divisions are made between the fourth class men and the pass men. Now the results obtained from this table should be influenced less by

tradition than those from any of the other fourfold tables dealing with fraternal correlation, because during this period all men, whether candidates for honours or not, were examined by the same set of examiners, and those who were considered worthy of honours were given them, though if they were only aiming at a pass degree they were not in any case placed higher than the fourth class. Thus a division between honours and no honours is probably a much better twofold division according to merit than any other which has been made in the tables, and consequently the effects of tradition on the results cannot be so great. If the effects of tradition in increasing the correlation coefficients are in reality very great, the correlation coefficient obtained from a table, in which they are known to be at any rate comparatively small if not entirely absent, should be markedly lower in value than those obtained from the other tables; instead of this we find that Table V D. gives a value of ·43, which is actually higher than the majority.

From the considerations detailed above we must conclude that tradition has some effect in increasing the apparent strength of heredity as measured hitherto in this paper, but that it is not so great an effect as might have been supposed and that it changes the fraternal coefficients more than it does the paternal.

E. *Conclusions.*

To return to the actual values obtained from the Oxford records, the mean value obtained for the fraction expressing the degree of resemblance between father and son, as deduced from the five correlation coefficients calculated, is ·312, and that between brother and brother, from the eight coefficients calculated, ·405. We will now compare these figures with corresponding ones calculated for easily and accurately measurable physical characters; a large number of these will be found in the paper "On the Laws of Inheritance in Man," by Professor Pearson and Miss Alice Lee (*Biometrika*, Vol. II. p. 357). If we select from all these those that deal with father and son, and brother and brother, we get the following results:

Correlation between	father and son	brother and brother
Stature	·514	·511
Span	·454	·549
Length of Forearm	·421	·491
Mean	·463	·517
Oxford Class Lists	·312	·405

It will be noticed that the mean values obtained from the Oxford class lists are in both cases lower than the mean values given for physical characters. But

in spite of the slight artificial raising of the former, which we have dealt with in the preceding section, it is only to be expected that they should be lower than the latter, even if they are the statistical expression of an intensity of inheritance of mental ability really of the same degree as that of the three physical characters referred to.

The reason for this is that, although a skilfully conducted examination lasting for four or more days is likely to give a reasonable estimate of a man's ability, yet serious mistakes are frequently made, so that it cannot be claimed that such an estimate is nearly as accurate as careful measurements of stature, span or length of forearm. It is also a matter of fact and not of theory or surmise that when the correlation coefficient between two variables is calculated, the nearer the measured value of each is to its true value, that is to say the more accurately each is measured, the higher the value of the coefficient will be; provided always that the error in the measure of the one variable is quite independent of that in the other. In the case of our own tables dealing with the classes obtained by fathers and sons, the one variable is the class obtained by the father and the other associated variable is the class obtained by his son. In some cases a father whose real ability may entitle him to one particular class, say the second, is placed wrongly, say in the third or fourth class; now if his sons are also intellectually entitled to a particular class, and the fact that their father has been placed erroneously below his proper class has no influence whatever in lowering the class in which they themselves are placed, then the values of the correlation or contingency coefficients obtained will be lower than they would be if in all cases both father and sons had been correctly placed. Since it is difficult to imagine that an error in the placing of the father could have any effect on the placing of the sons, so we argue from this that our coefficients have been lowered by the mistakes of the examiners, and therefore our results are not incompatible with the conclusion reached by Professor Pearson in his Huxley Lecture (*Biometrika*, Vol. III. p. 156) that "the physical and psychical characters in man are inherited within broad lines in the same manner and with the same intensity."

One point further must be referred to, namely the relative value of the paternal to the fraternal correlations. The mean value for the former for the physical characters which we have quoted is ·463 and for the latter ·517, thus they bear to one another the relation of 1 to 1·12; our own values are respectively ·312 and ·405, which bear to one another the relation of 1 to 1·30. Thus it will be seen that the relative value of fraternal to paternal correlation is larger in the case of examination results than of physical characters, being 1·30 instead of 1·12. This is quite in accordance with expectation if the conclusion, previously expressed, be correct, that tradition and other external causes have more effect in raising the fraternal coefficient than the paternal.

PART II.

THE EVIDENCE OF THE HARROW AND CHARTERHOUSE SCHOOL LISTS.

A. *Harrow.*

We owe the material on which this section is based to the kindness of Mr M. G. Dauglish, an old Harrovian and the editor of the *Harrow Register*. This work gives a list of all who entered the school from 1800—1900, which is probably perfectly complete and correct from the commencement of Dr Vaughan's headmastership in 1845; a short biographical notice of each name is given, including the father's name and the date of entry into the school. The position in the school of each boy included in our tables was ascertained from the four volumes of the *Harrow Calendar*, which are practically a reprint of the "Bill Books" from 1845—1891. It is perhaps necessary to explain that the "Bill Books" are lists published each term of all the boys in the school, arranged according to their position in the school. The "Blue Books" give the names in alphabetical order, but put the name of the class in which the boy is placed after each name. The last two volumes of the *Harrow Calendar* are indexed but the first two are not, so that both the labour of finding a boy's position in the school and the chance of errors in doing so are considerable, but as in making the tables those boys who came before 1858 are not used, only a small percentage occur in these first two volumes. In order to bring the list from 1891 up to date, a complete set of "Bill Books" and "Blue Books" from 1892 onwards was procured from the publisher, J. C. Wilbee, of Harrow.

After having made lists, as complete as possible, of all the sets of brothers who entered the school from 1858 onwards, their position in the school for comparable times in their careers was found out for each boy. As the dates of birth are not given in the register, but only the date of entry into the school, it was decided to take for the first fixed point the summer term following their year of entry, which was called year 1. The boy's position was found for this year and for the summer term in each subsequent year in which he remained in the school, which were called respectively year 2, year 3 and so on. These particulars were entered on slips of paper, one slip for each fraternity, which were sorted into two groups, one dealing with the earlier entries and one with the later. The former includes all those containing one member who entered the school in the years 1858—1870, although some of its members may have

entered the school later; the latter contains only those families of which no member entered before 1871, and it is with this group we deal first. Apart from the modern side, the divisions of which were difficult to bring into line with those of the rest of the school and which therefore are not included in the table, the school consisted in the summer of 1875 of the following divisions: (1) monitors, of whom nearly all were above the upper sixth, but possibly one or two in the upper or lower sixth; (2) upper sixth; (3) lower sixth. These together formed the uppermost of the seven main divisions of the school used in the tables; they contained in all 68 boys or 13·82 per cent. of the school; then came the fifth, divided into three divisions, an upper, middle and lower, of which the first two form our second division, consisting of 67 boys or 13·62 per cent. of the school; our third division includes the third division of the fifth and the upper division of the next form, the remove, and consists of 64 boys or 13·00 per cent., while the lower division of the remove, sub-divided for purposes of school work into two parallel classes, formed our fourth division, which consists of 72 boys or 14·63 per cent. of the school; our fifth division contained the upper shell, which like the lower remove was sub-divided into two parallel classes; this contained 71 boys or 14·43 per cent., while the middle and lower shells comprising 67 boys or 13·62 per cent. of the school formed our sixth division; and our seventh and last comprised the upper, middle and lower fourth, and contained 83 boys or 16·87 per cent. of the school. Thus it will be seen that for the purposes of our tables we have divided the school into seven roughly equal divisions, using the natural boundaries provided by the school classes; these seven divisions with practically the same boundaries remain approximately equivalent for the whole period of time covered by the later group. The three principal tables dealing with this group, VIII A., IX A., and X A., were made in precisely the same way as Tables IV A. and V A., which refer to the Oxford pairs of brothers, so it will be unnecessary to describe the details of their making. In Table VIII A. the boys are classed according to their position in year 1, that is to say in the summer term following their admission to the school. 637 families of brothers were used in making this table, of which 454 were families of 2, and thus contributed 908 pairs to the table, 128 were families of 3 and supplied 768 pairs, while the remainder of the total number of 2540 was made up of 432 derived from 36 families of 4, 300 derived from 15 families of 5, 90 derived from 3 families of 6, and 42 derived from one family of 7. For making Table IX A. where a classification according to the position in year 2 was used, the number of available families had sunk, owing to boys leaving or going on to the modern side, to 485, and as this was comprised of 342 families of 2, 104 families of 3, 27 families of 4, 9 families of 5, and 3 of 6, the total number of pairs was 1902. In the same way Table X A. deals with year 3; here we find that of the original 637 families only 350 were left, 262 of 2, 62 of 3, 18 of 4, 6 of 5, and 2 of

6 brothers, making in all 1292 pairs. When we came to the fourth year the number of families had sunk so low that it was not thought worth while to include them in this paper.

It would perhaps be as well at this point to enumerate briefly the results obtained from these three tables, reserving our comments on them for a later period. Firstly the mean square contingency coefficient (C_1) and the mean contingency coefficient (C_2) were calculated for each of them and the following values obtained, for VIII A., $C_1 = \cdot 39$, $C_2 = \cdot 38$; for IX A., $C_1 = \cdot 37$, $C_2 = \cdot 39$; for X A., $C_1 = \cdot 39$, $C_2 = \cdot 38$. The 49 divisions of each table were then reduced in two different ways to 4. Thus Table VIII A. provided Tables VIII B. and C.; in the former the divisions were taken between the upper and middle shells, and in the latter between the lower remove and upper shell. A value for the correlation coefficient r of ·28 was obtained from Table VIII B. and of ·36 from VIII C., the mean of the two being ·320. In deriving Table IX B. from IX A. those in the upper remove and above were separated from those in the lower remove and below, while in Table IX C. the dividing line was taken below the second division of the fifth. These tables give values of r of ·25 and ·46 respectively, averaging ·355. Tables X B. and X C., made from Table X A. by dividing it in the first case below the second division of the fifth and in the second case below the upper remove, give values of r of ·28 and ·35 of which the mean is ·315.

Having thus described the methods of treatment of, and the results obtained from the later group, we will turn our attention to the earlier one. It was not so easy in this case as in the last to obtain seven divisions of the school, which remained approximately equivalent during the whole period treated of, owing to a curious practice, which is also observable in the Charterhouse lists, of abolishing forms at the bottom of the school, and of inserting fresh ones in the middle. The apparently illogical nomenclature of school classes forms a sort of fossilized record of this practice. Thus at the present day both at Harrow and at Charterhouse the highest form with a numerical name is the sixth and the lowest is the fourth. Thirds, seconds and firsts have existed, but have been abandoned one by one even during rapid and continuous growth of the school, and their places have been taken by removes and shells thrust in between the older forms and by repeated sub-divisions of the latter. We are not concerned to find reasons for this practice, but since it added considerably to the complications of our task we were obliged to note it and deplore it.

In making our seven divisions in order to construct tables from the earlier material the first three are identical with the first three of the later group, except that as between 1865—1872 for what was formerly called the fourth division of the fifth another form (the upper remove) equivalent in position and size was substituted, so that before this change was made our third division consisted of the third and fourth divisions of the fifth, instead of the third division of the

fifth and the upper remove. With regard to our fourth division in 1859—1864 the remove taken together with the first division of the shell was found to be more nearly equivalent to the remove of later days than either of these classes taken separately; similarly in our fifth division, as there were four divisions of the shell up to 1872, each of them being single divisions (*i.e.* not sub-divided into two parallel classes), the first and second divisions are equivalent to the upper shell of 1873 and onwards, and to the second and third divisions of the same class in 1864 and earlier. For our sixth division the fourth division of the shell and the first division of the fourth, from 1859—1864, taken together are approximately equivalent to the third and fourth divisions of 1865—1872, and to the middle and lower shells of 1873 and onwards. For the seventh, all that was lower than the sixth was in each case included, an assortment which included a greatly shrunk third class for the first few years, until that relic was finally abandoned.

To turn to results. Table XI A. deals with the position of the brothers in year 1 and gives a value for the mean square contingency coefficient (C_1) of ·38 and for the mean contingency coefficient (C_2) of ·45; while converted into the fourfold table (XI B.) by dividing between our fifth and sixth divisions both vertically and horizontally it gives a value for the correlation coefficient (r) of ·44, or if the partitions are made between our fourth and fifth divisions (Table XI C.) of ·45. From Table XII A. in which the grouping is made according to the position of the brothers in year 2, C_1 was found to be ·39 and C_2 ·45; while the two values of r obtained by separating the table into four compartments by partitions between our third and fourth divisions as in Table XII B., and between our second and third as in Table XII C., are respectively ·45 and ·37. Table XIII A. is based on the position of the brothers in year 3; from it a value for C_1 of ·38 can be obtained and for C_2 of ·45. Table XIII B. is derived from Table XIII A. by separating it between our second and third divisions and gives a value for r of ·49, while from Table XIII C., in which the separation was made between our third and fourth divisions, the value of r was found to be ·42. We will not stop to discuss the significance of these results in this place, but will defer the consideration till we have those obtained from the Charterhouse lists for comparison.

B. *Charterhouse.*

The Charterhouse results are based on the names included in the *Charterhouse Register*. This work gives short biographical notices of all those who came down with the school in its move from Smithfield to Godalming in 1872 and of all who entered it since that date. Unfortunately the notices omit the names of the fathers, which should be considered an essential part of any biography, however short. It is earnestly to be hoped that this omission may be rectified in future editions, as the name of the father is most useful in identifying undistinguished people, who

are not labelled with any position or achievements of note. It is only through the kindness of Mr O. H. Latter, of Charterhouse, that we were enabled to do the work at all, for he supplied us with the particulars of all, or nearly all, those families of brothers whose names are included in the *Register*. To do this entailed on him an enormous amount of work, for which we wish to express to him our most sincere gratitude. On the recommendation of Mr Tod, of Charterhouse, one of the editors of the *Register*, we used, for finding the position of the brothers in the school at different ages, the Charterhouse "Blue Books"; and we have to thank Dr Rendall, the headmaster, for allowing us to be supplied from the school stationery shop with a complete set of these from 1872 onwards. These "Blue Books" are quite unlike the Harrow "Blue Books" in plan; they are printed once a year and give the names of the boys arranged in their forms and the results of the yearly examinations, which take place at the end of the cricket quarter. Since the date of the birth of each boy is given in the *Register*, it was possible to find from the "Blue Books" the form in which he was in the summer term of the year in which he reached any given age. The ages chosen in making the three contingency tables which are included in this paper are 15, 16, 17, as it was found that these were the three most common ages. As in the case of the Harrow tables, we have divided the school forms into seven groups, which we have tried to make as nearly as possible equivalent during the whole period covered. This necessitated a different grouping for every year for the first seven years, 1872—1878, as very rapid changes in arrangement took place during this period, but from 1881 the forms have remained practically the same, so that we have used the same grouping from that year onwards. It is as follows: A first division containing the sixth and under sixth forms and also the middle sixth on its introduction in 1896; second, third, fourth, fifth, sixth and seventh divisions made up of the fifth forms, remove, upper fourth, middle fourth, under fourth, and shell respectively. Our first division remained the same as far back as 1876, but in 1875 the first class of the fifth was added to it, and in 1872—1874, when there was no under sixth, the second class of the fifth was also included. If we follow our second division backwards we find it remaining the same till 1877, but in that year and in 1876 we included also the remove. In 1875, when the first class of the fifth had to be taken away in order to add it to the first division, the first class of the upper fourth was moved up to take its place; in 1874, as the second class of the fifth was also used in the same way, the whole of the upper fourth was included; and in 1872 and 1873, before the remove had come into existence, the whole of the upper and lower fourth. Our third division, which consists of the remove from 1878 onwards, was made up of the upper fourth in 1876 and 1877, of classes II. and III. of the upper fourth and of the under fourth in 1875, of the under fourth and classes I., II. and III. of the upper shell in 1874, of the upper shell and classes I. and II. of the under shell in 1873, and of the shell

in 1872, a class which forms the bottom of the school from 1878 onwards. Our fourth division, which was made up of the upper fourth from 1878 onwards, consisted of the under fourth only in 1876 and 1877, of the upper shell in 1875, of class IV. of the upper shell, of the middle shell and under shell in 1874, of classes III. and IV. of the under shell and of the upper third in 1873, and of the third form in 1872. Our fifth division consisted of the middle fourth form from 1881 onwards, the under fourth from 1878—80, the upper shell in 1876 and 1877, of the under shell and classes I. and II. of the upper third in 1875, of the upper third and classes I., II. and III. of the middle third in 1874, of the under third in 1873 and of the second form in 1872. Our sixth division was made up of the under fourth from 1881 onwards, of the upper shell from 1878—80, of the under shell in 1877, of the under shell and upper third in 1876, of classes III. and IV. of the upper third and middle third in 1875, of class IV. of the middle third, of the under third and classes I. and II. of the upper second in 1874, of the second form and class I. of the first form in 1873 and of the first form in 1872. Lastly the following forms were left over for the seventh division: In 1881 and onwards the shell, in 1878—80 the middle and under shells, in 1877 the third form, in 1876 the middle third, in 1875 the under third, in 1874 class III. of the upper second and the under second, in 1873 classes II. and III. of the first, and in 1872 a class which was placed below the first and called the Petties.

In Table XIV A. the material is grouped according as the brothers were in one or other of the seven divisions of which the limits are described above, during the year in which each reached the age of 15. The mean square contingency coefficient (C_1) calculated from this table is ·38 and the mean contingency coefficient (C_2) ·40, and the values of the correlation coefficient (r) are ·43 and ·41, according as the boundaries of the fourfold table are taken just above (Table XIV B.) or just below (Table XIV C.) the fourth division. In Table XV A. the positions of the brothers in the years in which they reached 16 are used. It gives a value of ·44 for C_1 and of ·46 for C_2, while from the fourfold table which is derived from it by putting the first and second divisions on the one hand and the third to the seventh on the other (Table XV B.) a value for r of ·47 can be calculated, while if the third division is included with the first and second (Table XV C.) the value is ·46. In making Table XVI A. the position of the brothers in the year in which they reached the age of 17 is used. From it values of C_1 and C_2 of ·44 and ·43 respectively are obtained, and from Tables XVI B. and C., which correspond exactly with Tables XV B. and C., values for r of ·48 and ·32 can be calculated.

C. *Conclusions.*

The statistical constants obtained from the consideration of the Harrow and Charterhouse brothers will be found summarized in Table XVII.; in the first column the mean square contingency coefficients are given. In glancing down this it will be found that they vary from ·37 to ·44, with a mean value of ·395. The mean contingency coefficients, which are set forth in the second column, are slightly more variable—·38 to ·46—and their mean value is ·415. The correlation coefficients show a far wider variability—·25 to ·49—but their mean value ·398 approaches very closely to that of the mean square contingency coefficient. It will be noticed that the values obtained for the correlation coefficients from the later of the two Harrow groups, given first in Table XVII., are markedly less than those obtained either from the earlier Harrow group or from Charterhouse, and as this difference is shown in each of the three tables one would be inclined to attach more importance to it than that to which in our opinion it is entitled. But it must be remembered that practically all the boys included in the tables relating to the third year are also included in those which relate to the second year, and similarly the material of the second year tables is also included in the first. Thus the results obtained from one year do not give much additional weight to those obtained from another, as would be the case if the material used in each was absolutely independent. Another reason for not attaching undue weight to the small value of these correlation coefficients is that they are very much less than the mean square contingency coefficients of which the average for this group is ·383, whereas the average of the correlation coefficients is ·330. We must therefore conclude that it is due to some abnormality of this particular material, a conclusion which is confirmed by the great difference between the two correlation coefficients for year 2 (·25 and ·46). The other differences visible in the table are probably well within the limits of the agreement which can be expected from this class of work. But we hold that the average values of the different constants, which will be found in the last line of Table XVII., may be taken as fairly accurate measures of the resemblance of one brother to another as shown by their position in school at corresponding ages, or at corresponding points in their school careers. They agree very well with one another and with the measure of fraternal resemblance obtained by the four square correlation method from the Oxford material, which on referring to Part I. will be found to be ·401. Like that number they must be considered to be minimum values, for, although it may be held that position in school affords a more accurate indication of mental worth than the result of a single examination, yet other disturbing factors creep into the consideration of the school results which do not exist or exist only in much lesser degree in the arguments

from the University lists. Thus both at Harrow and at Charterhouse the position was only taken at one point in the year, namely the summer term, therefore in the former case, as boys came to the school also in the Easter and autumn terms, there must be about eight months' difference in the length of time during which they had stayed at the school between the senior and the junior boy; and in the latter case, as boys are born at any time during the year, there is probably a year's difference in age between the oldest and youngest boy included in any one table, and eight months of school life or a year of one's age makes a considerable difference to one's position in the school. Apart from this, although the usual age for entering a public school is between the thirteenth and fourteenth birthdays, some boys enter earlier and some later. Thus in the Harrow tables there may be a fairly wide variation of age between all the boys who had been at the school a given length of time, and in the Charterhouse tables the same variation may occur in the length of time they had been in the school of all the boys of a given age. Since both his age and the length of time a boy has been in the school are factors affecting his position in it, it would appear at first sight that this variability would reduce the value of the contingency and correlation coefficients, and inasmuch as there is variability in this respect within each family, or at any rate within some of the families taken separately, it must undoubtedly do so. But it is probable that in some cases a parent sends all his sons to school either rather earlier or rather later than the average, and as this would have the effect of increasing the value of the coefficients, it is probable that the variation of the age of entry of the boys does not affect the results to any serious extent either one way or the other.

It will no doubt occur to our readers that the brain power of a boy at a given age depends on the rate at which his intellect developes besides his natural ability, and that we have left the former of these two factors out of consideration, although in all probability it varies as much as the latter. We do not think that our results are in any way spoilt by this, for, although it cannot be questioned that what we have measured is a character compounded of the two, yet, as there is no reason to suppose that either of them is inherited in a different way from the other, what is a measure of the inheritance of the combination is probably also a measure of the inheritance of each separately.

One more circumstance must be mentioned which tends to reduce the value of the fraternal coefficients. As all who were sons of the same father are included in the tables, and as the mothers were in no case known, a certain number of half-brothers are included as brothers, and as the correlation between half-brothers cannot be so high as that between brothers this admixture would have the effect of slightly diminishing the coefficients.

Having reviewed circumstances tending in the direction referred to above, we must say something of those which tend in the other direction, namely to increase

the size of the coefficients. The most obvious of these is the similarity of environment of different members of the same family; we can only say that we have reduced this as far as possible by taking only members of the same school or University together, yet it cannot be denied that home influences and previous education must have a certain effect and that this effect will be in the direction named. Yet it appears to us that the action of this factor must diminish in intensity as the boy grows older, for the similarity between the education of the different families becomes more and more complete as they spend more and more time in the same school under the same conditions. If therefore this factor has any serious effect on the results, we should look to see a steady diminution in the size of the coefficients as we pass from year 1 to year 2 and from year 2 to year 3 in the Harrow tables, and from age 15 to age 16 and to age 17 in the Charterhouse ones. Reference to Table XVII. shows us that no diminution of this kind does in reality exist, and thus we argue that the effect of environment is less than might have been supposed.

We must confess that we found it impossible to eliminate all spurious correlation, for in each case the relative values of the different classes have changed somewhat during the periods covered in the tables, the change being mostly in the direction of the increase in the size of the upper divisions; in this way towards the end of the period a slightly greater percentage of pairs of brothers must have been entered in the squares near the left hand top corner of the tables than at the beginning. The effect of this is to increase the size of the contingency and correlation coefficients. As however we were at pains to reduce this as much as possible by adjusting the school classes in the ways described, we hope and believe that our results are not seriously disturbed by it.

Summary of Results.

We started with the intention of measuring as exactly as possible the resemblance between father and son and brother and brother, as shown by their successes or failures in passing the examination for the B.A. degree at Oxford or by their position in school at Harrow and Charterhouse at corresponding times; and we stated that complete resemblance would be indicated by unity, and no resemblance at all by 0, the various degrees of partial resemblance by fractions lying between 0 and unity. We denoted, with references, the methods employed in doing this, namely the contingency method and the fourfold correlation method, and we gave reasons why reliance should be placed, when dealing with the Oxford material, on results obtained by the latter rather than by the former of these. These results were for the correlation between father and son ·312 and between brother and brother ·405.
Dealing with the public school material it was impossible to compare father and

son, so that only the correlation and contingency coefficients between brother and brother were calculated; the mean value obtained from all the tables for the former was ·398, which shows a remarkably close agreement with that obtained from the Oxford material, ·405, and also agrees with the mean values of the contingency coefficients ($C_1 = {}$·395, $C_2 = {}$·420). We endeavoured to show why the values should be considered as minimum values; we argued from this that they are not incompatible with the conclusion reached by Professor Pearson in his Huxley Lecture before the Anthropological Institute (*Biometrika*, Vol. III., p. 156) "that the physical and psychical characters in man are inherited within broad lines in the same manner and with the same intensity."

In conclusion, we must express our sincere thanks to Mr Galton and to Professor Karl Pearson for the most valuable help and advice which they have given us.

TABLE I A. *Date of Son's Degrees*, 1861—92.

Fathers

		Honours				Pass Degree	No Degree	Totals
		First Class	Second Class	Third Class	Fourth Class			
Sons: Honours	First Class	27	27	14	13	53	15	149
Sons: Honours	Second Class	52	54	33	30	138	22	329
Sons: Honours	Third Class	47	64	47	42	157	20	377
Sons: Honours	Fourth Class	20	27	22	17	91	13	190
Sons	Pass Degree	41	79	95	87	479	87	868
Sons	No Degree	31	39	46	52	277	101	546
Totals		218	290	257	241	1195	258	2459

$C_1 = \cdot 26$, $C_2 = \cdot 29$.

TABLE I B.

Fathers

	Honours Classes I & II	Honours Cl. III & IV, Pass Degree, No Degree	Totals
Sons: Honours Classes I & II	160	318	478
Sons: Honours Classes III & IV, Pass Degree, No Degree	348	1633	1981
Totals	508	1951	2459

$r = \cdot 29$.

TABLE I C.

Fathers

	Honours Classes I, II & III	Honours Class IV, Pass Degree & No Degree	Totals
Sons: Honours Cl. I, II & III	365	490	855
Sons: Honours Class IV, Pass Degree & No Degree	400	1204	1604
Totals	765	1694	2459

$r = \cdot 30$.

TABLE I D.

Fathers

	Honours Classes I, II, III & IV	Pass Degree & No Degree	Totals
Sons: Honours Classes I, II, III & IV	536	509	1045
Sons: Pass Degree & No Degree	470	944	1414
Totals	1006	1453	2459

$r = \cdot 28$.

Table II A.

Fathers

Sons		Honours First Class	Honours Second Class	Honours Third Class	Pass Degree	No Degree	Totals
Honours	First Class	20	16	9	27	14	86
Honours	Second Class	32	27	15	60	11	145
Honours	Third Class	22	15	19	46	9	111
Honours	Fourth Class	11	18	16	45	13	103
Pass Degree		67	74	75	371	113	700
No Degree		20	30	30	184	122	386
Totals		172	180	164	733	282	1531

$C_1 = \cdot 29$, $C_2 = \cdot 31$.

Table II B.

Fathers

Sons	Honours Classes I & II	Honours Class III, Pass Degree, No Degree	Totals
Honours Classes I & II	95	136	231
Honours Classes III & IV, Pass Degree, No Degree	257	1043	1300
Totals	352	1179	1531

$r = \cdot 34$.

Table II C.

Fathers

Sons	Honours Classes I, II & III	Pass Degree & No Degree	Totals
Honours Cl. I, II & III	175	167	342
Honours Class IV, Pass Degree & No degree	341	848	1189
Totals	516	1015	1531

$r = \cdot 33$.

Table III.

Measures of Resemblance between Father and Son, found by different methods.

Date of Degrees taken by Sons	C_1 = Mean square Contingency Coefficient	C_2 = Mean Contingency Coefficient	r = Correlation Coefficient found by the 4-fold Correlation Method			Mean of r's
			found from Table I C.	found from Table I D.	found from Table I E.	
1860—1892	·26	·29	·29	·30	·28	·290
			found from Table II B.	found from Table II C.	—	
1830—1860	·29	·31	·34	·33	—	·335

Table IV A. *Date of Degree,* 1860—1892.

First Brother

		Honours: First Class	Honours: Second Class	Honours: Third Class	Honours: Fourth Class	Pass Degree	No Degree	Totals
Second Brother: Honours	First Class	56	98	59	18	70	38	339
	Second Class	98	156	148	54	136	76	668
	Third Class	59	148	166	72	200	105	750
	Fourth Class	18	54	72	32	103	60	339
Pass Degree		70	136	200	103	576	260	1345
No Degree		38	76	105	60	260	286	825
Totals		339	668	750	339	1345	825	4266

$C_1 = {\cdot}32$, $\quad C_2 = {\cdot}39$.

Table IV B.

First Brother

Second Brother	Honours Classes I & II	Honours Classes III & IV, Pass Degree & No Degree	Totals
Honours Classes I & II	408	599	1007
Honours Classes III & IV, Pass Degree & No Degree	599	2660	3259
Totals	1007	3259	4266

$r = \cdot 38$.

Table IV C.

First Brother

Second Brother	Honours Classes I, II & III	Honours Class IV, Pass Degree & No Degree	Totals
Honours Classes I, II & III	988	769	1757
Honours Class IV, Pass Degree, No Degree	769	1740	2509
Totals	1757	2509	4266

$r = \cdot 40$.

Table IV D.

First Brother

Second Brother	Honours Classes I, II, III & IV	Pass Degree & No Degree	Totals
Honours Classes I, II, III & IV	1308	788	2096
Pass Degree & No Degree	788	1382	2170
Totals	2096	2170	4266

$r = \cdot 40$.

TABLE V A. *Date of Degree*, 1830—1860.

First Brother

Second Brother		Honours				Pass Degree	No Degree	Totals
		First Class	Second Class	Third Class	Fourth Class			
Honours	First Class	68	48	31	31	81	28	287
Honours	Second Class	48	72	46	44	127	48	385
Honours	Third Class	31	46	36	33	110	41	297
Honours	Fourth Class	31	44	33	44	120	53	325
Pass Degree		81	127	110	120	856	357	1651
No Degree		28	48	41	53	357	178	705
Totals		287	385	297	325	1651	705	3650

$C_1 = \cdot30$, $C_2 = \cdot36$.

TABLE V B.

First Brother

Second Brother	Honours Classes I & II	Honours Cl. III & IV, Pass Degree, No Degree	Totals
Honours Classes I & II	236	436	672
Honours Classes III & IV, Pass Degree, No Degree	436	2542	2978
Totals	672	2978	3650

$r = \cdot37$.

TABLE V C.

First Brother

Second Brother	Honours Classes I, II & III	Honours Class IV, Pass Degree, No Degree	Totals
Honours Cl. I, II & III	426	543	969
Honours Class IV, Pass Degree & No Degree	543	2138	2681
Totals	969	2681	3650

$r = \cdot39$.

TABLE V D.

First Brother

Second Brother	Honours Classes I, II, III & IV	Pass Degree & No Degree	Totals
Honours Classes I, II, III & IV	686	608	1294
Pass Degree & No Degree	608	1748	2356
Totals	1294	2356	3650

$r = \cdot43$.

Table VI A. *Date of Degree,* 1800—1830.

First Brother

Second Brother		Honours: First Class	Honours: Second Class	Honours: Third Class	Pass Degree	No Degree	Totals
Honours	First Class	56	34	26	71	24	211
Honours	Second Class	34	28	32	100	38	232
Honours	Third Class	26	32	40	127	33	258
Pass Degree		71	100	127	832	360	1490
No Degree		24	38	33	360	226	681
Totals		211	232	258	1490	681	2872

$C_1 = \cdot 31, \quad C_2 = \cdot 29.$

Table VI B.

First Brother

Second Brother	Honours Classes I & II	Honours Cl. III & IV, Pass Degree, No Degree	Totals
Honours Classes I & II	152	291	443
Honours Classes III & IV, Pass Degree, No Degree	291	2138	2429
Totals	443	2429	2872

$r = \cdot 42.$

Table VI C.

First Brother

Second Brother	Honours Classes I, II & III	Honours Class IV, Pass Degree & No Degree	Totals
Honours Cl. I, II & III	308	393	701
Honours Class IV, Pass Degree & No Degree	393	1778	2171
Totals	701	2171	2872

$r = \cdot 43.$

TABLE VIII A.

First Brother

Second Brother	Sixth	First and Second divisions of Fifth	Third div. of Fifth & Upper Remove	Lower Remove	Upper Shell	Middle & Lower Shells	Fourth	Totals
Sixth	—	4	2	6	3	1	2	18
First and Second divisions of Fifth	4	36	41	20	18	17	5	141
Third division of Fifth and Upper Remove	2	41	80	70	42	63	24	322
Lower Remove	6	20	70	110	100	103	87	496
Upper Shell	3	18	42	100	92	119	89	463
Middle & Lower Shells	1	17	63	103	119	174	110	587
Fourth	2	5	24	87	89	110	196	513
Totals	18	141	322	496	463	587	513	2540

$C_1 = \cdot 39$, $C_2 = \cdot 38$.

TABLE VIII B.

First Brother

Second Brother	Upper Shell & Higher	Middle Shell & Lower	Totals
Upper Shell & Higher	930	510	1440
Middle Shell & Lower	510	590	1100
Totals	1440	1100	2540

$r = \cdot 28$.

TABLE VIII C.

First Brother

Second Brother	Lower Remove & Above	Upper Shell & Below	Totals
Lower Remove & Above	512	465	977
Upper Shell & Below	465	1098	1563
Totals	977	1563	2540

$r = \cdot 36$.

Table IX A.

First Brother (columns); Second Brother (rows)

	Sixth	First and Second divisions of Fifth	Third div. of Fifth & Upper Remove	Lower Remove	Upper Shell	Middle & Lower Shells	Fourth	Totals
Sixth	54	57	25	27	6	6	2	177
First and Second divisions of Fifth	57	128	70	79	40	27	5	406
Third division of Fifth and Upper Remove	25	70	72	91	59	46	11	374
Lower Remove	27	79	91	94	51	58	8	408
Upper Shell	6	40	59	51	38	30	12	236
Middle & Lower Shells	6	27	46	58	30	54	18	239
Fourth	2	5	11	8	12	18	6	62
Totals	177	406	374	408	236	239	62	1902

$C_1 = \cdot 37, \qquad C_2 = \cdot 38.$

Table IX B.

First Brother (columns); Second Brother (rows)

	Upper Remove & Above	Lower Remove & Below	Totals
Upper Remove & Above	558	399	957
Lower Remove & Below	399	546	945
Totals	957	945	1902

$r = \cdot 25.$

Table IX C.

First Brother (columns); Second Brother (rows)

	Second division of Fifth & Above	Third division of Fifth & Below	Totals
Second division of Fifth & Above	296	287	583
Third division of Fifth & Below	287	1032	1319
Totals	583	1319	1902

$r = \cdot 46.$

Table X A.

First Brother

Second Brother	Sixth	First and Second divisions of Fifth	Third div. of Fifth & Upper Remove	Lower Remove	Upper Shell	Middle & Lower Shells	Fourth	Totals
Sixth	170	108	51	18	3	3	—	353
First and Second divisions of Fifth	108	138	106	54	12	6	1	425
Third division of Fifth and Upper Remove	51	106	60	35	18	7	—	277
Lower Remove	18	54	35	26	8	7	1	149
Upper Shell	3	12	18	8	4	4	1	50
Middle & Lower Shells	3	6	7	7	4	6	1	34
Fourth	—	1	—	1	1	1	—	4
Totals	353	425	277	149	50	34	4	1292

$C_1 = \cdot 39$, $C_2 = \cdot 38$.

Table X B.

First Brother

Second Brother	Second division of Fifth & Above	Third division of Fifth & Below	Totals
Second division of Fifth & Above	524	254	778
Third division of Fifth & Below	254	260	514
Totals	778	514	1292

$r = \cdot 28$.

Table X C.

First Brother

Second Brother	Upper Remove & Above	Lower Remove & Below	Totals
Upper Remove & Above	898	157	1055
Lower Remove & Below	157	80	237
Totals	1055	237	1292

$r = \cdot 35$.

TABLE XI A.

First Brother

Second Brother	I*	II	III	IV	V	VI	VII	Totals
I	—	2	2	2	—	—	—	6
II	2	6	25	13	11	6	5	68
III	2	25	102	79	55	52	25	340
IV	2	13	79	68	86	53	43	344
V	—	11	55	86	124	99	65	440
VI	—	6	52	53	99	170	99	479
VII	—	5	25	43	65	99	100	337
Totals	6	68	340	344	440	479	337	2014

* For explanation of these figures *vide* text.

$C_1 = \cdot 38$, $C_2 = \cdot 45$.

TABLE XI B.

First Brother

Second Brother	V and Above	VI and Below	Totals
V and Above	850	348	1198
VI and Below	348	468	816
Totals	1198	816	2014

$r = \cdot 44$.

TABLE XI C.

First Brother

Second Brother	IV and Above	V and Below	Totals
IV and Above	422	336	758
V and Below	336	920	1256
Totals	758	1256	2014

$r = \cdot 45$.

Table XII A.

First Brother (columns); Second Brother (rows)

	I	II	III	IV	V	VI	VII	Totals
I	10	29	19	10	2	2	—	72
II	29	124	92	56	31	14	5	351
III	19	92	92	71	36	19	6	335
IV	10	56	71	84	47	21	5	294
V	2	31	36	47	60	33	14	223
VI	2	14	19	21	33	28	4	121
VII	—	5	6	5	14	4	4	38
Totals	72	351	335	294	223	121	38	1434

$C_1 = \cdot 39$, $C_2 = \cdot 45$.

Table XII B.

First Brother (columns); Second Brother (rows)

	III and Above	IV and Below	Totals
III and Above	506	252	758
IV and Below	252	424	676
Totals	758	676	1434

$r = \cdot 45$.

Table XII C.

First Brother (columns); Second Brother (rows)

	II and Above	III and Below	Totals
II and Above	192	231	423
III and Below	231	780	1011
Totals	423	1011	1434

$r = \cdot 37$.

TABLE XIII A.

First Brother (columns); Second Brother (rows)

	I	II	III	IV	V	VI	VII	Totals
I	66	72	19	13	4	—	1	175
II	72	126	54	22	10	4	—	288
III	19	54	62	24	8	2	1	170
IV	13	22	24	22	11	3	—	95
V	4	10	8	11	4	—	—	37
VI	—	4	2	3	—	—	—	9
VII	1	—	1	—	—	—	—	2
Totals	175	288	170	95	37	9	2	776

$C_1 = \cdot 38$, $C_2 = \cdot 45$.

TABLE XIII B.

First Brother (columns); Second Brother (rows)

	II and Above	III and Below	Totals
II and Above	336	127	463
III and Below	127	186	313
Totals	463	313	776

$r = \cdot 49$.

TABLE XIII C.

First Brother (columns); Second Brother (rows)

	III and Above	IV and Below	Totals
III and Above	544	89	633
IV and Below	89	54	143
Totals	633	143	776

$r = \cdot 42$.

TABLE XIV A.

First Brother (columns); Second Brother (rows)

	I	II	III	IV	V	VI	VII	Totals
I	—	9	2	1	2	—	—	14
II	9	72	64	56	38	22	5	266
III	2	64	76	60	67	36	6	311
IV	1	56	60	100	81	68	14	380
V	2	38	67	81	106	89	30	413
VI	—	22	36	68	89	102	47	364
VII	—	5	6	14	30	47	14	116
Totals	14	266	311	380	413	364	116	1864

$C_1 = \cdot 38, \qquad C_2 = \cdot 40.$

TABLE XIV B.

First Brother (columns); Second Brother (rows)

	III and Above	IV and Below	Totals
III and Above	298	293	591
IV and Below	293	980	1273
Totals	591	1273	1864

$r = \cdot 43.$

TABLE XIV C.

First Brother (columns); Second Brother (rows)

	IV and Above	V and Below	Totals
IV and Above	632	339	971
V and Below	339	554	893
Totals	971	893	1864

$r = \cdot 41.$

Table XV A.

First Brother

Second Brother	I	II	III	IV	V	VI	VII	Totals
I	26	39	9	3	2	3	—	82
II	39	216	113	79	49	17	—	513
III	9	113	74	80	45	23	4	348
IV	3	79	80	94	74	36	8	374
V	2	49	45	74	66	24	9	269
VI	3	17	23	36	24	30	5	138
VII	—	—	4	8	9	5	2	28
Totals	82	513	348	374	269	138	28	1752

$C_1 = \cdot 44$, $C_2 = \cdot 46$.

Table XV B.

First Brother

Second Brother	II and Above	III and Below	Totals
II and Above	320	275	595
III and Below	275	882	1157
Totals	595	1157	1752

$r = \cdot 47$.

Table XV C.

First Brother

Second Brother	III and Above	IV and Below	Totals
III and Above	638	305	943
IV and Below	305	504	809
Totals	943	809	1752

$r = \cdot 46$.

Table XVI A.

First Brother (columns); Second Brother (rows)

	I	II	III	IV	V	VI	VII	Totals
I	94	93	17	12	5	—	—	221
II	93	238	90	48	16	3	—	488
III	17	90	60	44	17	5	—	233
IV	12	48	44	24	8	3	1	140
V	5	16	17	8	20	3	—	69
VI	—	3	5	3	3	—	—	14
VII	—	—	—	1	—	—	—	1
Totals	221	488	233	140	69	14	1	1166

$C_1 = \cdot 44,\quad C_2 = \cdot 43.$

Table XVI B.

First Brother (columns); Second Brother (rows)

	II and Above	III and Below	Totals
II and Above	518	191	709
III and Below	191	266	457
Totals	709	457	1166

$r = \cdot 48.$

Table XVI C.

First Brother (columns); Second Brother (rows)

	III and Above	IV and Below	Totals
III and Above	792	150	942
IV and Below	150	74	224
Totals	942	224	1166

$r = \cdot 32.$

Measures of Resemblance between Brother and Brother found by different methods.

TABLE VII.

OXFORD.

Date of Degrees taken by Sons	C_1 = Mean square Contingency Coefficient	C_2 = Mean Contingency Coefficient	r = Correlation Coefficient found by the 4-fold Correlation Method			Mean of r's
			found from Table IV B.	found from Table IV C.	found from Table IV D.	
1860—1892	·32	·39	·38	·40	·40	·393
			found from Table V B.	found from Table V C.	found from Table V D.	
1830—1860	·30	·36	·37	·39	·43	·397
			found from Table VI B.	found from Table VI C.		
1800—1830	·31	·29	·42	·43		·425

TABLE XVII.

HARROW AND CHARTERHOUSE.

Material	Year or Age of Boy	Mean square Contingency Coefficient	Mean Contingency Coefficient	Correlation Coefficient	Correlation Coefficient	Mean Correlation Coefficient
Harrow, later	Year I	Table VIII A.	Table VIII A.	Table VIII B.	Table VIII C.	
		·39	·38	·28	·36	·320
	Year II	Table IX A.	Table IX A.	Table IX B.	Table IX C.	
		·37	·38	·25	·46	·355
	Year III	Table X A.	Table X A.	Table X B.	Table X C.	
		·39	·38	·28	·35	·315
Harrow, earlier	Year I	Table XI A.	Table XI A.	Table XI B.	Table XI C.	
		·38	·45	·44	·45	·445
	Year II	Table XII A.	Table XII A.	Table XII B.	Table XII C.	
		·39	·45	·45	·37	·410
	Year III	Table XIII A.	Table XIII A.	Table XIII B.	Table XIII C.	
		·38	·45	·49	·42	·455
Charterhouse	Age of Boy, 15	Table XIV A.	Table XIV A.	Table XIV B.	Table XIV C.	
		·38	·40	·43	·41	·420
	Age of Boy, 16	Table XV A.	Table XV A.	Table XV B.	Table XV C.	
		·44	·46	·47	·46	·465
	Age of Boy, 17	Table XVI A.	Table XVI A.	Table XVI B.	Table XVI C.	
		·44	·43	·48	·32	·400
General Means.........		·395	·420			·398

APPENDIX.

INFLUENCE OF ACADEMIC SELECTION ON CORRELATION COEFFICIENTS.

By KARL PEARSON, F.R.S.

In the course of the present memoir it has been assumed that the fathers and sons who go to Oxford are not an intellectually selected class. In other words the academic population is supposed to have as great intellectual variability as the community at large. This can hardly be the case; in the first place, there is a mild intellectual test in the matriculation examinations, which excludes at least some of the very intellectually defective. Secondly, there is already a class selection; there has been in the near or distant past ability in the stock sufficient to raise it to that pecuniary position in which going to the university becomes a tradition; thirdly and lastly, a considerable number of men go to Oxford because they have shown by position in their schools, or by obtaining school or college scholarships, that they are likely to do well at the university. There is small doubt therefore that the academic population belongs to a selected class and one with considerably less intellectual variation than is to be found in the community at large. This selection of intelligence leads at once to the reduction of the correlation coefficients between father and son, and brother and brother. It would be very difficult to obtain a precise numerical estimate of the amount by which the academic population is less intellectually variable than the general population. The reduction can hardly be less than 15 per cent.*, and some estimates might make it as high as 25 per cent., owing to the heaping up of the specially intelligent group by the prizes and rewards offered to very capable boys in a considerable number of social classes†. It seems worth while investigating the results which arise from supposing 15 and 25 p.c. of selection.

Let ρ_{12} be the observed correlation between fathers and sons both at the university; r_{12} the true correlation of intelligence between father and son in the race; μ the ratio of variability in the academic population to that in the community at large in the matter of intelligence. Then‡

$$r_{12} = \rho_{12}/\sqrt{\mu^2 + \rho_{12}^2(1-\mu^2)}.$$

Now $\rho_{12} = \cdot 33 = \frac{1}{3}$ say; hence in the present case

$$r_{12} = 1/\sqrt{1+8\mu^2}.$$

* This would be about the sort of reduction which would arise if we cut off the bulk of the slow dull and very dull members of the general population.

† Certain intellectually selected classes send their sons by tradition; other classes send only the pick of their intelligence.

‡ *Phil. Trans.*, Vol. 200 A, p. 39.

If $\mu = \cdot 85$, i.e. 15 p.c. reduction in variability of intelligence, $r_{13} = \cdot 385$. If $\mu = \cdot 25$, i.e. 25 p.c. reduction in variability of intelligence, we have $r_{13} = \cdot 43$.

But these values do not represent the whole reduction, because a similar selection has taken place with regard to sons. They represent the correlation between fathers at or not at the university and sons at the university. Accordingly repeating the calculations with $\rho_{13} = \cdot 385$ and $\cdot 43$ respectively, we find for r_{13}' the correlation of father and son in general:

$$r_{13}' = \cdot 44 \text{ and } \cdot 54 \text{ respectively.}$$

No special stress is laid on these particular numerical results, but they suffice to show that, if the variability in intelligence in the academic population be 15 to 25 per cent. less than in the general population, the actual correlation in intelligence between father and son as a racial heredity constant must lie between $\cdot 44$ and $\cdot 54$, i.e. much in excess of the value $\cdot 33$ deduced from the selected population.

Assuming the observed correlation of brothers of the academic class to be $\cdot 4$, and using the same formulae, i.e.

$$r_{34} = \rho_{34} / \sqrt{\mu^2 + \rho_{34}^2 (1 - \mu^2)},$$

where ρ_{34} is the observed and r_{34} the actual fraternal correlation in intelligence in the general community, we find, by the selection of the first brother, $r_{34} = \cdot 46$, if the variability be reduced by 15 p.c., and $r_{34} = \cdot 50$, if it be reduced 25 p.c. These are the values of fraternal correlation for one brother at the university and the other at or not at the university. Repeating the process with $\rho_{34}' = \cdot 46$ and $\cdot 50$, we find that, owing to the selection of both brothers, $r_{34}' = \cdot 52$ with 15 p.c. reduction and $= \cdot 61$ with 25 p.c. reduction.

Accordingly it seems reasonable to suppose that if the intelligence of the academic class has a less wide range of variability than that of the general population, the coefficient of parental heredity for intelligence lies between $\cdot 4$ and $\cdot 5$, and that of fraternal resemblance between $\cdot 5$ and $\cdot 6$.

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EUGENICS LABORATORY MEMOIRS. II.

A FIRST STUDY OF THE STATISTICS OF INSANITY AND THE INHERITANCE OF THE INSANE DIATHESIS

BY

DAVID HERON, M.A.

SECOND GALTON RESEARCH FELLOW IN NATIONAL EUGENICS
UNIVERSITY OF LONDON

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The Laboratory is under the supervision of Professor Karl Pearson, F.R.S., in consultation with Mr Francis Galton, F.R.S.

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Some reconstruction of the Francis Galton Laboratory having taken place, it seemed desirable to provide the workers associated with it with a direct channel of publication of their own, in which their more extended memoirs should appear. It is hoped that the present series may be issued at short intervals. Subscribers should notify their intention of taking in the memoirs as they are published to Messrs Dulau & Co. Requests to exchange with similar publications, with archives and journals dealing with demographic and sociological problems, or with census reports should be directed to The Editor, Eugenics Laboratory, University College, Gower Street, London, W.C.

A First Study of the Statistics of Insanity and the Inheritance of the Insane Diathesis.

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(1) *Introductory.* It will appear at first sight presumptuous that a layman should venture into a field which has been so much cultivated by the trained medical mind, and where such numerous pitfalls exist for those unacquainted with the various phases of mental disease popularly grouped under the broad term insanity. Even to the layman it may indeed seem imperative that each type of mental disease should be dealt with separately and the problem of inheritance considered for each apart. Undoubtedly this must form the last word on the subject, the final treatment of the "inheritance of insanity" when the data are available. But is the time ripe for any such investigation? May it not be that a broader treatment from the side of popular terminology may be in itself helpful as stimulating the minds of those in charge of the insane to see the question of heredity from another standpoint—that of the statistician? What appears from the statistical side at present so urgent is the need that those who have not only the opportunity but the clinical training necessary for accurate observation, should record their facts in a form in which the trained statistician can apply to them the methods of modern statistics. A careful examination of the Annual Reports of the Asylums of Great Britain and Ireland has led to the conviction that no data at present published would enable the statistician to reach any quantitative results as to the inheritance of any single form of brain disease. Even medical treatises as a rule go no further than stating the percentage of cases in which insanity or some other want of mental balance has been recorded in the family history. As long as we do not know the total number in each class of relatives of the insane person and the exact brain defect from which they have suffered; as long as we do not know the total number of relatives of a random sample of the sane population and the exact forms of neurosis or brain disease from which they too have suffered, any attempt at a full treatment of the "inheritance of insanity" is from the statistical standpoint

idle. What advantage can possibly arise from telling us that an insane person has so many alcoholic uncles if we do not know either the total number of his parents brothers and sisters, or the percentage of alcoholic members in the same grade of relationship of a sane individual of the same social class? But if an examination of the Annual Reports of the Asylums shows the statistician that little of real value for the problem of inheritance is as yet to be found in them, it does provide evidence that in many quarters the medical officers have themselves realised this fact. One sees evidence here and there that the need for slowly and steadily collecting complete family histories is being more and more recognised. This dull plodding work may not appear to have much fascination for those who long at once for brilliant generalisations and rapid conclusions; it is like the slow work of the astronomer who piles up data that his successor a century hence may by comparing the positions of stars at distant intervals learn the truth. But may we not apply to the medical investigator the words of Sir David Gill in his Presidential Address and urge that for him also the supreme duty is "to secure for future generations those data the value of which grows by time"?

These words are not written without some knowledge of the difficulties which attend the collection of complete family histories. It is admitted at once that the duties of many medical officers are far too multifarious to allow of work of this kind, of whatever national importance it may be; there are many of them whose tastes and abilities lead them in a different direction. It wants tact and even "slimness" to elicit the plainest facts, but the guile of the uneducated who form the bulk of the material is often of a very shallow kind, and it does not require much experience and knowledge on the part of the investigator to circumvent it*. It does, however, need the temperament that is not easily discouraged and is patient with much talking.

And again, even if the relatives are willing to give the fullest information in their power, what too often does it amount to? Why the statement that a grandparent, an aunt, or cousin was eccentric, alcoholic or "insane." They are too often wholly unable to specify the particular type of insanity, its cause or even duration. With the material at present available it would be almost idle to attempt any treatment of the inheritance of a special type of insanity. Sometimes the inquirer may have had the relative under his own charge, or may be able from the layman's account to make a shrewd guess at the type of illness, but in a very large number of cases we must be content with the broad statement that an Ancestor was "insane." The solution of this difficulty, and the present writer believes of many other difficulties in the statistics of

* It is not always, however, so transparent as in the following case narrated by a medical officer who takes very full family histories and sees (and compares the accounts of) all available relatives. In this case a father and mother had brought a son to the asylum. The father had been cross-examined and had stoutly maintained that there was no family history on either side. The medical officer in parting with him said he would like to see the mother, whom he had heard had also come to the asylum with the son would the man send her in? After some hesitation, he replied that he could not do so at present, for she was visiting a sister in the women's wards!

insanity is to establish a General Register of the Insane for preservation in the office of the Lunacy Commissioners. Each insane person would receive an index number, and this number would be preserved in case of transfer, relapse after recovery, or even permanent recovery. In this manner we should be able to estimate closely not only the total insane population, but also the number of the population who had at any time been insane, which is a very different matter, yet one of immense importance from the standpoint of heredity and of national eugenics. By inquiry of the keepers of this General Register of the Insane it would ultimately be possible for the medical officer of the future to complete in a great number of cases the particulars as to the ancestor, John Smith, stated by the relatives to have been "insane." It is thus that I would illustrate my reference to Sir David Gill's words. In special cases, especially in private practice, it may be possible in other ways to follow up the special type of insanity, but it must be remembered that the insane are not a very large proportion of the community, and for final conclusions the statistician will need very large numbers of each special type. We are justified in doubting whether such material can ever be accumulated except through the combined effort of many medical officers of the largest public asylums; yet it is precisely in such cases that the personal knowledge of the family is so often lacking. It can, we believe, only be supplied by that General Register of the Insane to which reference has just been made.

There are, however, two further points which suggest themselves to a layman approaching the subject from the statistical side. Some forms of insanity may be of singular distinctness and capable of differentiation from the mass of others with practical unanimity of the experts. But can we say that the experts will themselves agree to a general classification of types, or admit that some of these types may not be manifestations at different stages of the same original constitutional defect? It would seem that already there is more than a tendency among experts to revert to Dr Sankey's position "that insanity is but the process, and that the so-called varieties are merely differentiated by non-essential phenomena; that all insanities begin with melancholia, and tend to pass through a succession of stages in the order—melancholia, mania, and dementia, a succession liable at any time to interruption by recovery." In short, to take Dr Urquhart's position that "Insanity is a unity, not a fortuitous collection of kaleidoscopic systems each requiring a proper name*." It is not for a layman to express an opinion on this point, but while there is diversity of expert views, and while many hold the possible transition from one type to another, and treat insanity as a unity, the popular statement that John Smith had an "insane" ancestor may not be of such small scientific value as it appears at first sight. Initially this compulsory limitation of the method by which we may hope to reach conclusions may not result in such a heterogeneous and loose classification as some mental experts would suggest.

* See *Journal of Mental Science*, Vol. LIII. pp. 241 and 243.

The second point to which I would refer is one that touches closely on this first consideration. In the mass of family histories slowly accumulating in the Eugenics Laboratory, there appears to the observer a certain "correlation in heredity." Insane stock are liable to tuberculosis at a greater rate than sane stock; mentally defective offspring occur in families in which neuroses, alcoholism or insanity are more or less frequent. Physical or mental degeneracy of one type will be found in one member, and of a second type in a second member. There is, as it were, an inherited tendency to general degeneracy, which is something wider even than the vague "insanity," where many types are clubbed together under one name. This correlation in heredity manifests itself in other directions; the inherited tendency to digital defect may appear in one member as excess, in another as a true defect; and ophthalmic surgeons have drawn attention to the fact that abnormality of vision may take different forms in parent and offspring. It would appear as if the stock suffered from hereditary determinants which were unstable in character, and that the existence of such unstable determinants may be the mark of "degenerate" stock; the instability may be marked by more than one form of insanity, or states less emphasised than the insane, such as the neuroses which may be classed as want of mental balance. It may be long before material has been accumulated in sufficient mass to test quantitatively the forms of "cross-heredity" here referred to. We may hereafter find that even a wider category than the popular phrase "insanity" is the more truly scientific, that the inheritance of insanity is like the inheritance of pulmonary tuberculosis, the inheritance of a tendency, a condition or state, which under the suitable environment, the special mental or physical strain, the influenzal weakening or some kindred source, may become one form or another of accepted insanity. It is possible that this insane diathesis, the characteristic of the neurotic stirp is what we ought scientifically to treat as our heredity-unit. As a somatic measure of its existence and intensity the general term "insane" has been taken in this paper; just as in a similar investigation* the presence or absence of pulmonary tuberculosis—the result possibly of infection—has been taken as a measure of the intensity of the tubercular diathesis.

Even from this limited standpoint the question of the inheritance of insanity becomes of much interest; the very defects of the method showing how needful are further data and how many points are yet statistically without answer. When the classification of the types of insanity shall have proceeded further, when above all the family records shall have given us information as to these types in ascendant, descendant and collateral, then our insight will be deeper and we shall be able to test statistically the inheritance of each type and the correlation in heredity between types. In the opinion of the present writer this correlation should always be kept in view as a goal, even if a distant one, in dealing with family histories under the present difficulties. But while we strive for more definite data in greater quantities from

* Pearson, "A First Study of the Statistics of Pulmonary Tuberculosis," *Drapers' Research Memoirs* Dulau & Co.

the pathological side, is it not also worth pressing upon those who have medical science at heart, that no final treatment of the inheritance of any abnormal condition can be reached, until we have much more ample knowledge than we have at present of the family history of normal individuals? That is the *sine quâ non*, failing which no treatment of the inheritance of pathological conditions is valid. It is the endeavour to supply these data which leads in the present case to the difficulties and assumptions of our investigation.

(2) *Statistical Method.* In the preceding section we have discussed the justification such as it is of treating insanity as a unity, as a mark which denotes that certain members of a neurotic stock have in a more or less definite degree the conditions which lead to a mental breakdown of one or another type. We may express this by saying that they have a certain intensity of the insane diathesis. Now what we are concerned with is the inheritance of this insane diathesis, i.e. of those constitutional conditions, which under certain environments lead the individual to omissions or commissions on the basis of which he or she will find their way into an asylum, or be certified as insane. Theoretically we suppose that there exists a quantitative scale of this insane diathesis. In some individuals the extent or intensity of this constitutional condition is so low, that under no physical or mental strain would they be in the least likely to become insane. In others the intensity is so great, that they are unlikely under any circumstances to escape the slight pressure which will suffice to send the balance down on the wrong side. In others again an absolutely easy and physically well regulated life will preserve them, as similar conditions will preserve the well-to-do who come of tuberculous stock. But the possibility of such conditions lies only with the well-to-do, not with the struggling and often exceedingly ignorant mass of humanity which provides the bulk of the population of our public asylums. Even a long way above this level few lives can be spent without, especially at certain periods, considerable physical or mental strain. Is the intensity of the insane diathesis sufficient in such cases to lead to temporary or permanent confinement in an asylum? Theoretically we want a mark on the scale of the insane diathesis, and then we shall say that under the normal environment of the present age, all who fall below this escape the asylum, all who exceed it will sooner or later be certified. Now it is quite clear that this is practically unattainable; A and B may be sensibly in equal possession of the insane diathesis, but A's environment or habit of life may preserve his sanity and B's destroy his. But the question is not whether any theoretical mark can be exact, but whether it can be drawn sufficiently close to the actual state of affairs to be useful in describing that state in the mass. We believe that the classification into sane and insane is probably as close as any made in vital statistics. There are undoubtedly a considerable number of neurotics, eccentrics and "cranks," who under a modified environment would need to be classed as insane. The time may actually come when we shall be able to recognise

other marks on the scale of insane diathesis beside the division which under the normal environment of modern life leads to a certificated insanity. A lower mark might for many social and family purposes be of value. Our only mark at present is not a true line, it is rather of the nature of a region or blur upon the scale, but if the scale be sufficiently long relatively to this region, this does not necessarily invalidate its usefulness.

Premising such a practical division if we take N pairs of individuals and form a fourfold table thus:

TABLE I.

First Individual.

Second Individual.	Sane	Insane	Totals	
Sane ...	a	b	$a+b=p_2N$	$p_1+q_1=1$
Insane ...	c	d	$c+d=q_2N$	$p_2+q_2=1$
Totals	$a+c=p_1N$	$b+d=q_1N$	$a+b+c+d=N$	

by classifying the member of each pair under the heading of sane or insane, we shall be able to judge of the relationship in the matter of sanity. In this case $b+d$ will represent the number of insane individuals in the community of the type of the first individual, $a+c$ the corresponding number of sane ones. Now it is quite conceivable that some few individuals who fall into the $a+c$ group have a greater intensity of the insane diathesis than some of those actually included in the certified insane $b+d$. But it is contended that although the division between $a+c$ and $b+d$ is a blur, and individuals near that region may be classified according to circumstances in one or other category, this is not so large a proportion* as to invalidate conclusions drawn from a table of this kind. Let us speak of the first individual as belonging to Class A, and of the second individual as belonging to Class B. Then if the link between Classes A and B had no influence at all on the intensity of the insane diathesis, the chance of the first individual being sane would be p_1, and of the second individual being sane would be p_2, and in a population of N pairs the number of pairs of sane individuals to be expected would be Np_1p_2. Similarly the number of cases in which both individuals were insane would be Nq_1q_2. Again, the chance of the first individual being insane and the second sane would be Nq_1p_2, and the first sane and the second insane would be Np_1q_2. Thus our fourfold table, if the intensity of the insane diathesis in the Classes A and B is independent is:

* The law courts allow us to estimate something of the extent of the blur in one social class, and so to form conclusions as to the proportion in all classes. I am not dealing here with the large number admitted by their relations to be insane, but who in the same social class are not for family reasons certified.

TABLE II.

First Individual.

Second Individual.	Sane	Insane	Totals
Sane ...	Np_1p_2	Nq_1p_2	Np_2
Insane ...	Np_1q_2	Nq_1q_2	Nq_2
Totals	Np_1	Nq_1	N

It will be noted that in this table all the totals are the same as in the previous case, but the numbers in each of the four classes are not necessarily the same.

Now
$$a - Np_1p_2 = a - (a+c)(a+b)/N = \frac{ad-bc}{N^2}N,$$
$$d - Nq_1q_2 = d - (b+d)(c+d)/N = \frac{ad-bc}{N^2}N.$$

Similarly, $Nq_1p_2 - b = \frac{ad-bc}{N^2}N$, and $Np_1q_2 - c = \frac{ad-bc}{N^2}N$.

Thus we can pass from the second table with independent degrees of the insane diathesis in the Classes A and B to that of the first class with some dependence of the insane diathesis, by transferring the fraction $\eta = \frac{ad-bc}{N^2}$ of the total population from both of the mixed groups (sane–insane) to either of the like groups. Or, when there is relationship between the intensities we emphasise the like groups by a proportion η of the total population. It will be at once clear that $\eta = 0$ is the sufficient condition for independence of the two groups. For example, if $\eta = 0$, when the first group consists of parents and the second of offspring, there cannot be inheritance of the insane diathesis from parent to offspring. It does not follow that if η differ from zero, that there is of necessity true inheritance, the relationship might be due to a common environment of each pair differentiated from the environment of other pairs. But if we find, working fairly in one class with a moderate normal intensity of environment, that η is very considerable, it is highly probable that the relationship is due in great part to inheritance. Indeed much that is often put down to environment—commendable or objectional personal habits, control or want of control of economic environment—results from inheritance itself, and may be only another phase indeed of the inheritance of that neurotic constitution which is part of the insane diathesis.

It is clear that η is a numerical quantity, and all our inquiry ultimately turns on what is the relative magnitude of η. But it is convenient to measure intensity of relationship by a quantity which shall lie between -1 and $+1$,

being 0 when the quantities are independent, $+1$ when one is absolutely determined positively, and -1 when one is absolutely determined negatively by the second. Now such a quantity is termed a coefficient of correlation, it is a measure of the intensity of resemblance between two individuals of related classes. Clearly there may be more than one function of η which satisfies such conditions, it may also be a function of p_1 and p_2 since these depend only on the individual classes and not on their relationship. Thus we may write for our correlation constant

$$r = \text{function of } \eta_1, p_1 \text{ and } p_2.$$

The problem arises: what is the nature of the function we shall choose? Now it would be valuable to choose one the intensity of which shall be independent of the position of the mark on the supposed scale, which measures the intensity of the insane diathesis. For example, suppose we were capable of drawing it at a slight tendency to melancholia, then if we could choose a function which would give r the same value as when we draw the mark at certified insanity, it would be of great value. No attempt of this kind can however be made unless we have some knowledge of the distribution of the various intensities of the insane diathesis in the community—a so-called frequency distribution. We have at present no such knowledge, and accordingly in selecting r as a function of η we must be led by some hypothesis. This hypothesis is that within wide limits the distribution of frequency in physical, psychical and pathological characters in man approaches a certain type termed the Gaussian or normal type. We know that this is true for many measurable physical characters; there is considerable evidence that it is at least approximately true for a number of psychical characters. Recent work suggests that even in the matter of severity of attack in disease the maximum frequency is not with the mildest cases, but that the frequency rises from the mildest cases, reaches a maximum, and then falls to the severest cases. It may easily do this and still be far from possessing the full characters of the Gaussian distribution; but still as a first approximation and until we are in a position to determine the true frequencies of each intensity, the Gaussian scale may be used with partial justification and often with much suggestiveness. Whatever be the scale the sensible deviation of η or r from zero shows quite definitely that the character in the two classes is correlated, but the legitimacy of comparing the intensity of the correlation in this case with that of others undoubtedly depends for its weight on the degree of confidence we have in the basal character, in this case the intensity of the insane diathesis, following the normal distribution with at least a moderate approximation.

(3) *Values of Necessary Statistical Constants.* For the purposes of diagnosis as well as for eugenic inquiry, it is not sufficient to know what members of a stock are at the time of the investigation certified as insane. If the insane diathesis be

inherited, it is much more important to know the number of relatives who have at any time been certified as insane. In the present memoir we understand by the insane members of a family those who at any time in their lives have been treated as insane. Again, if we take actual asylum statistics and the family histories collected by their medical officers, we shall find in nearly all cases that the record is incomplete, that is to say, that there are members of the stock whose history with regard to possible insanity is not yet completed. These two considerations (a) the distinction that must be made between persons at present insane, and who have at some time in their life been insane, and (b) the incompleteness of the family histories, form the chief difficulties of and accurate investigation of the problem of insanity.

Let us return for a moment to Table I. To ascertain whether insanity is inherited or not, we need to take N individuals, who form a random sample of the community, or perhaps of some fairly homogeneous class of it. But the smallness of the class $b+d$ as compared with $a+c$ means that a very large sample N indeed has to be taken to get conclusive results. It is almost impossible to approach the inheritance of pathological conditions from the standpoint of a general sample of the population, unless a wide scheme of collecting family histories could be organised and carried out by combined action of the medical profession. We are reduced to approaching the problem indirectly. If we collect family histories within the asylums, we shall know subject to (i) the errors of the record, and (ii) the incompleteness of the record, the number of sane and insane relatives of the insane individual; we shall accordingly have the quantities b, d and c for a random sample of unknown size for any pair of related individuals. But we shall not know how many pairs of individuals both sane correspond to this sample—i.e. what is the magnitude of a. If we knew the ratio, however, of the number of sane to insane individuals in a random sample N of the community, we might from the ratio of $a+b$ to $c+d$ deduce the size of the fourth category a and so complete our random sample. To determine this ratio is the first problem; the second problem is the allowance for the incompleted family history.

When we remember that insanity is frequently temporary or intermittent, it will be obvious that for the purposes of inheritance we have no more justification for omitting a member of a family who has ever been in an asylum, than for excluding a person who for the present is in an asylum. Our goal must be to ascertain whether during the whole of life there has been evidence of that intensity of the insane diathesis which leads to certifying. Even here we are met by the disturbing factor that the neurotic condition may itself lead to shortness of life, and so to the reduction of the apparent amount of insanity in any insane stock. This factor, however, is one which we see no means of allowing for at present.

Accordingly for our present purposes the extent of insanity in the community cannot be measured by the percentage of the population at any time in the asylums of the country (assuming for the moment that all the certifiable in the social class dealt with are certified). What we desire to know is the number of living persons,

who at present, or at any time during their lives, have been insane. If there are m persons in an asylum at the present moment, and μm living who have been in that asylum but are now not in other asylums but following the ordinary life of the sane, what is the value of μ? Only by a knowledge of μ can we reach a measure of what for eugenic purposes is the force of insanity in the country; only by such means can we determine α even approximately. On first approaching this subject it appeared that it would be easy to find statistics bearing on this point, but it soon exhibited itself as a very intricate and difficult problem. Asylums could provide a record of patients dismissed as recovered, but the after fate of these recoveries was not easy to follow. It was not certain how far (i) they were identical with relapses in the same asylum, (ii) they were inmates of other asylums, or (iii) dead.

The impressions, not definite statistical data, of a number of medical officers on this point have been collected; they varied somewhat largely; perhaps, the most reliable estimate, the one that showed most careful thought for the various difficulties to be encountered was that $\mu =$ about 2, or the insane of the asylums must be multiplied by about three to deduce the force of insanity in the community. It is obvious that our proposed General Register of the Insane would at least provide us with the number of those at any time confined in an asylum and now no longer confined; it would also tell us much of the history of the once insane. But it would still fail to tell us of those who died after recovery and before the asylum census was taken. With the known age of dismissal, however, we approach a problem not impossible to the vital statistician or the actuary, if he were once in possession of a reliable system of death rates. Now these death rates at each age are known for the normal population; they are also known for the insane asylum population; but we do not know them at present for the "recovered" population. It is extremely unlikely that they are the same as for the normal population.

We know that between 15 and 25 the mortality of the insane is no less than 20 times that of the sane; between 25 and 45, about 11 times that of the sane; between 45 and 65, about 4·5 times; and over 65, about 2·5 times that of the sane*. In the total lunatic population for equal numbers of both sexes at the same ages, it is about 7 times as great as in the general population. Accordingly it is extremely unlikely that the death-rate of the "recovered" will be that of the general population; it will probably at each age lie between that of the latter and that of the insane.

At this stage Dr John Macpherson of the Scottish Lunacy Commission came to our aid and kindly furnished the Laboratory with a progressive history of 1319 insane patients who were admitted for the first time to Scottish Asylums in 1868. The history of this group is traced until 1897. From these figures an endeavour has been made to determine approximately the number of persons in the sane population who have at any time been in an asylum. The problem is far from being an easy one. The data were the number dying in the asylums each year, the number discharged

* *Report of Commissioners in Lunacy*, Mortality of Insane for 1904.

and the number readmitted out of the original 1319. Of those dying outside the asylums, there was of course no record. There was no hope of very great exactitude in the solution, for the age data were not available, but even so the problem was not actuarially an easy one. It was kindly undertaken for the Eugenics Laboratory by "Student" at that time working in the Biometric Laboratory, and the results of his analysis are given below*. We may obtain a lower limit to those who have ever been in an asylum by assuming that the death-rate among those who have recovered is the same as among those who are actually insane. This assumption gives a living population of recovered insane approximately equal to the number of asylum insane.

The second assumption made was that for the first six years after recovery the death-rate was half that of the insane, or about 35 per 1000 and afterwards fell to 30 per 1000, remaining constant at that figure until all were dead about 60 years after first admission. This assumption gives a population of recovered insane of about 1·5 times the asylum population.

The third assumption made was that the death-rate remained constant at about 20 per 1000 during the first 20 years after recovery, subsequently rising uniformly until all were dead at 70 years after admission. On this assumption the recovered insane population is about three times that of the actually insane.

This gives, perhaps, an upper limit to the number of living and recovered insane, the estimate of our best judge was *twice* the asylum population. According to the three assumptions we must multiply the insane population by 2, 2·5 and 4 respectively to obtain the force of insanity in the population.

Our material, to be discussed in the next section, being drawn from a Scottish source, we have next to enquire what is the extent of actual insanity in Scotland. According to the Scottish Census Report of 1901, there were in that year 13,668 individuals returned as "lunatics," of whom 13,457 were returned as over 20 years of age. The total population of Scotland numbered 4,472,103, of whom only 2,520,866 were over 20 years. It is clear that if we base the ratio of the sane to the insane upon the total population we shall have a very different result to that arising from limiting our population and cases to over 20. We cannot take into account the infant population because in our family histories starting from the offspring, one of whom is already in an asylum, we practically exclude infancy and deal only with the adult population. From the above figures we find that out of 1000 individuals over 20 years 5·32 are insane.

If instead of taking the census returns, we take the figures given in the Scottish Lunacy Commissioners' Report for 1901, we find that there were on the 1st of January, 1901, 15,475 lunatics of all ages. The age distribution is not given in this case, but if we assume that it is approximately the same as in the Census Report, then out of 1000 adult individuals 6·04 are insane. Accordingly between ·5 and ·6 per cent.

* A full discussion of it is not entered into here, because we hope shortly to be provided with more complete data and to enter then on a full treatment of this most important point.

adult individuals in Scotland are actually insane, and on the basis of our three estimates we must say that 10 to 12, 12·5 to 15, 20 to 24 per 1000 of the adult population respectively are or have been at some time insane. Our tables have been worked out on the three assumptions, namely, we suppose that 1, 1·5 and 2 per cent. of adults are from the inheritance standpoint to be considered insane. Values for a 2·5 per cent. base have also been extrapolated; these would correspond to the Lunacy Commissioners' returns with a death-rate for the "recovered," only slightly above that of the general population.

A further investigation was made and a considerable time spent upon it with a view to determining whether the social class from which the patients in our data were drawn provided a greater or less than normal quota to the total insane population. This was a point which might to some extent modify our results. It is a point also of very vital interest to the community at large. The data as to calling and position in our material were fairly ample; but the census classifications on which we had to work were so hopelessly vague that ultimately we had to give up the problem in despair. The class distribution of lunacy cannot be determined until the census categories are selected with somewhat greater reference to the needs of the sociological investigator.

The manner in which we can deal with the incompleteness of the family history will be discussed later under the separate tables.

(4) *Material.* The material on which the present memoir is based was most kindly provided by Dr A. R. Urquhart, physician superintendent of the James Murray's Royal Asylum, Perth. In this asylum the patients are all paying patients*, and may fairly be said from the occupations of the record to belong to the middle and lower middle classes. Hence it would have been desirable to determine the special lunacy rate for these classes, but for the reason given above we can only take the general lunacy rate of the country†. Dr Urquhart has been at the head of this asylum for nearly thirty years, and has remained in touch with patients who have been discharged to a much greater extent than is frequently the case. The records which have been compiled by Dr Urquhart personally are therefore of great value on account of their completeness, uniformity and the long period over which they extend. If the statistician wish for a greater mass of material, he knows only too well that this can only be forthcoming when more medical officers are willing to provide data like those of Dr Urquhart.

The Perth records consist of 331 family trees. Each gives the total number of brothers and sisters of the patient, stating the order of birth and in many cases the

* The ordinary minimum board-rate is £84 per annum, but a few patients are admitted at reduced rates.

† Pearson's Family Records seem to indicate a higher rate than the Scottish 1 to 2 per cent. for middle class families, but 300 families are not sufficient to justify any final conclusions.

age of each, and classifying each as insane, neurotic, alcoholic, epileptic, eccentric or normal. Similar facts are in every case given about the parents of the patient, while in some cases the record is extended to the grandparents and to the children of the patient. The total number of the parents' brothers and sisters is, however, not invariably given. In the case of insane individuals the age at first attack is nearly always given. Occasionally, although the total number in the sibship of the patient is given, the order of birth has not been ascertained, or the age at first attack is wanting. It thus happens that the total number of cases used in the different investigations of this memoir will not be invariably the same. The material itself forms the basis of the statistical part of Dr Urquhart's recent most interesting Morison Lectures*; the present writer in that case supplied the table dealing with the differential incidence in the family, a point further discussed below, and this memoir appeals at points to data already tabulated by Dr Urquhart.

(5) *Preliminary Statistical Investigation.* It is needful before starting on the direct investigations as to inheritance to form a fairly definite idea of the mean age of incidence of the first attack. Table III gives Dr Urquhart's data for a series of 400 males and 382 females, and the calculated means and standard deviations are placed below.

TABLE III. *Age of First Attack.*

Age	Under 20	20—24	25—29	30—34	35—39	40—44	45—49	50—54	55—59	60—64	65—69	70—74	75 and upwards	Totals
Males	45	52	66	55	38	34	29	28	13	17	15	7	1	400
Females ...	21	55	68	53	35	38	26	36	13	11	10	9	7	382

	Males	Females
Mean Age of Onset =	$36{\cdot}2 \pm {\cdot}5$,	$36{\cdot}5 \pm {\cdot}5$ years.
Standard Deviation =	$14{\cdot}7 \pm {\cdot}4$,	$14{\cdot}7 \pm {\cdot}4$ years.

It will be noted at once that these data would indicate an equal age at incidence of insanity in both sexes and an equal variability at that age. But although the material is far from ample enough to warrant any attempt at present at further analysis, it does not seem that insanity differs from cancer or pulmonary tuberculosis in giving an equal average age of first attack for both sexes. The trained eye of the statistician will mark at once that not only are both distributions very skew, but they differ in the two sexes, youthful insanity being more prevalent in the male, senile insanity in the female; the apparent equality of mean ages being due to actual differences of the distribution in middle and late middle life. In fact there is

* On Insanity with special Reference to Heredity and Prognosis. *The Journal of Medical Science*, Vol. LIII. p. 233 *et seq.*, April 1907.

little doubt of the heterogeneity of the age frequency distributions; they must be when the material is ample enough divided up into their components in the manner in which the general mortality curve has been treated by Pearson*, and the general sickness curve by Elderton†. There is an insanity of youth with its modal age between 25 and 29, one of early middle life centering about 40, one of change of life, centering 50—54, and these are apart from senile insanity occurring at a later stage. The relation of these components to the corresponding mortality and sickness factors would form an extremely interesting study, but the investigation must, if it is to be profitable, be postponed until the data can be reckoned by thousands not hundreds of cases for each sex.

A sample taken out of Dr Urquhart's records of 219 cases gave a mean age of $37{\cdot}9 \pm {\cdot}6$ and a standard deviation of $13{\cdot}6 \pm {\cdot}4$, thus confirming the general result reached above.

Now the chief bearing of this result on our present investigation is of the following kind: the average age at first attack being 36, the average age of the parents must be nearly sixty, or the parents will have reached an age at which 90 per cent. of persons, who are ever insane will have had their first attack. But there is a still more cogent point, there is an inheritance not only of the diathesis, but in most cases of disease an inheritance of the approximate age of incidence. Thus if the offspring were to show insanity of youth at 25, the parent who will then be nearly 50, would have passed the danger zone at least for that class of insanity; while if the offspring shows insanity at change of life, the parent will have passed the period practically of senile insanity. Accordingly in the great bulk of cases, if we start from the insane patient, we may be fairly sure that the parental history is practically completed. In other words given a random sample of asylum patients we know fairly accurately (supposing the record not in error) how many are born of sane, how many of insane parents. On the other hand, when we turn to the enquiry as to the offspring of insane parents, we are on less certain ground, because the record of the younger generation may be far less complete. What we actually find is this, that of 198 sons born of insane parents 49 were recorded as insane, and of 210 insane daughters 52 were recorded as insane. In other words 25 per cent. of the offspring of insane persons at one time or another in their lives exhibited insanity. Now Pearson has found that even in the incomplete records of families with pulmonary tuberculosis, 30 per cent. of the offspring of a tuberculous parent exhibit tuberculosis, and that when the family history is completed he considers it probable that nearer 50 per cent. of the offspring will be recorded as tuberculous. The difficulty then arises as to whether our category of the insane offspring of insane parents is sufficiently largely represented. The point can only be settled when a full supply of wholly completed family histories is available. But the following points should be noted: (i) Dr Urquhart's data have been accumulating for 30 years and in many cases the record is

* *Phil. Trans.* Vol. 186 A. pp. 406—411. † *Biometrika*, Vol. II. pp. 260—272.

actually complete, the members of the same stock coming to the same asylum; (ii) Pearson's Family Records, indicate an even higher percentage (see Appendix). (iii) the argument from tuberculosis is not valid; the present insanity data are more complete than the tuberculosis data, because the mean age of first attack is higher and because the families have been under observation during a longer period; yet the unmodified record gives a sensibly lower percentage of offspring attacked than in the case of tuberculosis, namely 25 per cent. as against 30 per cent. There is no reason why the incidence should be the same in the two cases unless we start with some definite theory as to inheritance, e.g. the Mendelian. In Table IV below there is, however, little to warrant the application of that doctrine to the present data.

TABLE IV.

Nature of Parents as to Insanity	Total Offspring		Percentage Offspring	
	Insane	Sane	Insane	Sane
Both Sane ...	314	1179	21	79
One Insane ...	93	299	24	76
Both Insane ...	4	4	50	50

Now these results are, remembering the probable error of the last result, singularly close to those found by Pearson for pulmonary tuberculosis*. They compel us to consider sanity as dominant, which involves the following scheme:

TABLE V.

Matings	Expected to have Diathesis	Recorded to have Diathesis	
		Tuberculosis	Insanity
$(RR) \times (RR)$	100 per cent.	57 per cent.	50 per cent.
$(RR) \times (DR)$	50 per cent.	29 per cent.	24 per cent.
$(DR) \times (DR)$	25 per cent.	21 per cent.	21 per cent.

No argument in favour of Mendelism seems possible on these figures†. Here, as in the case of tuberculosis, there is no obvious reason why the expectation should be so much more closely fulfilled by the record in the third mating than in either of the other two. No great stress is really to be laid, however, on the apparently close agreement of the two diseases, because the record for insanity is probably much more complete. The question of how far other members of the patient's sibship would be

* "A First Study of the Statistics of Pulmonary Tuberculosis," *Drapers' Research Memoirs*, Dulau & Co., 1907.

† Exactly as in the tuberculosis data, the percentages required to complete the Mendelian proportions are wholly different in the three cases, whereas we should expect them to be the same.

classified as insane if the record were completed up to death was investigated in another manner. If we take as our "subject" the oldest member in the sibship of the insane, then we should anticipate that the greater his age at the time of the record, the larger would be the recorded number of insane in the sibship. The actual number of insane lies between 1 and 4 to the sibship, and the correlation between age of the oldest member and the number of insane was found to be $\cdot 14 \pm \cdot 04$. I think we are justified therefore in concluding that, owing to the incompleteness of the record, a small but definite correlation exists between number of insane and age of oldest member of sibship. But the magnitude of the correlation is not such as to sensibly affect our results. Such effect as it would exercise must tend however to increase the measure of inheritance.

We have accordingly made no attempt in the present case to correct the number of insane offspring of insane parents as found from the sibships of the insane, merely noting that it is probably too low. The *desideratum* is a selected series of completed family histories, or what is the same thing, of ancestral histories carried back fully to the grand-parental generation. When these are forthcoming in sufficient number we may endeavour to apply further corrections to our results.

(6) *Parental Inheritance.* Counting each insane patient twice, once for each parent, we find that the 410 male patients had 49 insane and 361 sane parents. The insane parents were further credited with 149 sane offspring. Dealing with female patients, we find that 52 had insane parents and 360 sane parents, and that these 52 insane parents were credited with 158 sane offspring. Thus Tables VI and VII give the data worked out for male and female pedigrees respectively. In these both father and mother are included as separate parents; and both sons and daughters are included in the offspring. The distinction between the two tables lies in the fact that in the first case we proceed from the record of 205 male patients, and in the second case from 206 female patients. The object of the double treatment is merely to divide the material into two groups for purposes of confirmation. The amount of material was not sufficient to justify us in breaking it up into the four sub-groups which would be needful had we dealt with inheritance from mother and father to son and daughter.

TABLE VI. *Male Pedigrees.*

Parents.

		Insane	Not Insane	Totals
Offspring.	Insane ...	49	361	410
	Not Insane	149	x	$149+x$
	Totals	198	$361+x$	$559+x$

TABLE VII. *Female Pedigrees.*

Parents.

		Insane	Not Insane	Totals
Offspring.	Insane ...	52	360	412
	Not Insane	158	x	$158+x$
	Totals	210	$360+x$	$570+x$

The next stage in the investigation is to find x the number of pairs of sane parents and offspring which would correspond to these results as a random sample of the general population. This is done by treating the patients, i.e. the offspring, as forming the basis of the random sample. The parents whether insane or sane are not a random sample, for they are selected by the very fact that they have become parents. Thus if our results can be relied on, the proportion of the insane among the members of the general population who are parents ought only to be about half as large as the proportion of the insane among the general population as a whole. This seems a not unreasonable conclusion.

Tables VIII, IX, X, XI, XII and XIII, give Tables VI and VII reduced to random samples of the general population on the basis of 1, 1·5 and 2 per cent. of that population having at one or other period in their lives been insane*.

COMPLETE TABLES, RANDOM SAMPLES OF GENERAL POPULATION. 1 °/° BASIS.

TABLE VIII. *Male Pedigrees.*

Parents.

Offspring.	Insane	Not Insane	Totals
Insane ...	49	361	410
Not Insane	149	40441	40590
Totals	198	40802	41000

TABLE IX. *Female Pedigrees.*

Parents.

Offspring.	Insane	Not Insane	Totals
Insane ...	52	360	412
Not Insane	158	40630	40788
Totals	210	40990	41200

COMPLETE TABLES, RANDOM SAMPLES OF GENERAL POPULATION. 1·5 °/° BASIS.

TABLE X. *Male Pedigrees.*

Parents.

Offspring.	Insane	Not Insane	Totals
Insane ...	49	361	410
Not Insane	149	26774	26923
Totals	198	27135	27333

TABLE XI. *Female Pedigrees.*

Parents.

Offspring.	Insane	Not Insane	Totals
Insane ...	52	360	412
Not Insane	158	26897	27055
Totals	210	27257	27467

* The process is perfectly simple, e.g. taking the 1·5 per cent. basis, then in Table VI we must have 410 equal to 1·5 per cent. of $559 + x$, or $410/(559 + x) = 1·5/100$. Hence $x = 26774$.

COMPLETE TABLES, RANDOM SAMPLES OF GENERAL POPULATION. 2°/。 BASIS.

TABLE XII. *Male Pedigrees.*

		Parents.		
		Insane	Not Insane	Totals
Offspring.	Insane ...	49	361	410
	Not Insane	149	19941	20090
	Totals	198	20302	20500

TABLE XIII. *Female Pedigrees.*

		Parents.		
		Insane	Not Insane	Totals
Offspring.	Insane ...	52	360	412
	Not Insane	158	20030	20188
	Totals	210	20390	20600

These six tables were then dealt with by the processes briefly indicated in § (2). In every case η was not only significant, but very markedly significant. There can thus be not the slightest doubt about the inheritance in a marked manner of the insane diathesis, the test for its presence being taken as sojourn in an asylum during some period of life. The equations determining r for each table are given below, and the results, together with those for a 2·5 per cent. basis deduced by extrapolation are given in Table XIV.

From Table VIII:

$$3{\cdot}069{,}329 = r + 3{\cdot}010{,}076r^2 + 4{\cdot}188{,}927r^3 + 2{\cdot}236{,}540r^4 - {\cdot}011{,}683r^5 + {\cdot}585{,}298r^6 + {\cdot}892{,}381r^7 - {\cdot}043{,}283r^8, \qquad r = {\cdot}61.$$

From Table IX:

$$3{\cdot}089{,}375 = r + 2{\cdot}988{,}390r^2 + 4{\cdot}118{,}229r^3 + 2{\cdot}162{,}678r^4 - {\cdot}010{,}614r^5 + {\cdot}606{,}953r^6 + {\cdot}870{,}504r^7 - {\cdot}038{,}999r^8, \qquad r = {\cdot}62.$$

From Table X:

$$2{\cdot}214{,}009 = r + 2{\cdot}652{,}858r^2 + 3{\cdot}077{,}276r^3 + 1{\cdot}125{,}\ 91r^4 - {\cdot}073{,}535r^5 + {\cdot}660{,}835r^6 + {\cdot}424{,}804r^7 - {\cdot}052{,}418r^8 + {\cdot}383{,}431r^9, \qquad r = {\cdot}58.$$

From Table XI:

$$2{\cdot}229{,}678 = r + 2{\cdot}631{,}684r^2 + 3{\cdot}018{,}521r^3 + 1{\cdot}070{,}584r^4 - {\cdot}059{,}248r^5 + {\cdot}668{,}376r^6 + {\cdot}408{,}629r^7 - {\cdot}038{,}513r^8 + {\cdot}388{,}975r^9, \qquad r = {\cdot}58.$$

From Table XII:

$$1{\cdot}755{,}039 = r + 2{\cdot}402{,}228r^2 + 2{\cdot}398{,}719r^3 + {\cdot}602{,}828r^4 - {\cdot}042{,}817r^5 + 612{,}475r^6 + {\cdot}182{,}548r^7 - {\cdot}002{,}088r^8, \qquad r = {\cdot}55.$$

From Table XIII:

$$1{\cdot}769{,}983 = r + 2{\cdot}381{,}450r^2 + 2{\cdot}014{,}833r^3 + {\cdot}574{,}832r^4 - {\cdot}012{,}929r^5 + {\cdot}612{,}159r^6 + {\cdot}173{,}175r^7 - {\cdot}035{,}394r^8, \qquad r = {\cdot}56.$$

The close agreement not only between the final results in each case for the male and female pedigrees, but in the coefficients of the equations themselves is noteworthy and justifies our extrapolation for the case of 2·5 per cent.

TABLE XIV. *Ancestral Heredity, assuming various Percentages of Insane.*

	On 1 °/₀ Basis	On 1·5 °/₀ Basis	On 2 °/₀ Basis	On 2·5 °/₀ Basis
Male Pedigrees ..	·61	·58	·55	·52
Female Pedigrees ...	·62	·58	·56	·53

The values obtained are undoubtedly rather high, even on the 2·5 °/₀ basis. It is possible that the prevalence of the insane diathesis in the community at large has been somewhat underestimated, proceeding as we do from the asylum evidence of its existence. Pearson, proceeding on the wider basis of "want of mental balance" and including the eccentric, neurotic and alcoholic, obtained a distinctly lower value*. But comparing the above results as they stand with those reached by other investigators for pathological conditions, for physical measurements and mental characters, summarised in Table XV, we must conclude that:

The insane diathesis is inherited with at least as great an intensity as any physical or mental character in man. It forms, considering the difficulties and assumptions of the investigation, probably no exception to an orderly system of inheritance in man, whereby *on an average* about one half of the mean parental character, whether physical, mental or pathological, will be found in the child. It is accordingly highly probable that it is in the same manner as other physical characters capable of selection or elimination by unwise or prudential mating in the course of two to three generations.

If it be said that the inheritance of insanity has been long a well recognised clinical experience, we can only reply: Let it be admitted. At the same time it is needful to point out that the whole of the medical data hitherto published on the subject seem lacking in the precision needful to give a logical proof. Not only will one, two and even sometimes three of the numerical values necessary for the fourfold table which demonstrates the existence of the association be found lacking, but the consciousness that they are lacking be also absent. A point so fundamental for the whole appreciation of heredity as the number of the insane, recovered and alive, has not so far as we are aware been hitherto taken into account. Heredity is over and over again recorded as a principal or contributory cause of insanity, although the average number of the insane in the stock of the sane individual has not been discussed. With equal logic the insanity of one member of a family might be

* *British Medical Journal*, May 27, 1905.

considered as the principal or contributory cause of the sanity of the sane members. It is the old story, which needs endless reiteration. From statistics of the pathological section of the population alone no argument as to inheritance can be deduced. Only by actual data as to the normal section can the evidence of the pathologist be made complete. It is necessary to supplement the data which the asylum or sanatorium provides, either directly by large random samples of the general population, or indirectly by census or other vital statistics.

TABLE XV. *Intensity of Parental Inheritance.*

Condition	Source of Data	Computer and Locus	Minimum Value	Maximum Value	Probable Value
Pathological:					
Pulmonary Tuberculosis ...	Dr River's, Crossley Sanatorium	Pearson, *Studies in National Deterioration*, II.	·40	·60	·50
Deaf Mutism ...	Dr Fay's Data ...	Schuster, *Biometrika*, Vol. IV., p. 466 et seq.	·45	·62	·54
Insanity ...	Dr Urquhart's Data	Heron, Present Memoir ...	·52	·62	·57
Physical:					
Stature	Pearson, Family Measurements	Pearson and Lee, *Biometrika*, Vol. II., p. 378	·49	·51	·50
Span			·45	·46	·46
Forearm ...			·41	·42	·42
Eye-Colour ...	Galton, Family Records	Pearson and Lee, *Phil. Trans.*, A 195, p. 106 et seq.	·44	·55	·50
Psychical:					
Intelligence ...	Pearson, Family Schedules	E. M. Elderton, Pearson, *Scope of Eugenics*, pp. 31—3	—	—	·58
" ...	Oxford, Class Lists ...	Schuster and Elderton, *The Inheritance of Ability*, p. 41	·44	·54	·49

(7) *Fraternal Inheritance.* Our data enable us to test how far the above appreciation of the intensity of the inheritance of the insane diathesis is confirmed by the resemblance in this character of siblings, i.e. brothers and sisters. When the material available is far larger than at present, it will certainly be desirable to separate the sexes. But as we have only 315 families, and the mean age of first attack is very much the same for both sexes, they have in this memoir been dealt with together.

Now out of the 315 families with one sibling insane, there were 404 insane individuals and 1433 sane individuals, when we have excluded children who "died in infancy" or who are under 20 years of age and have not yet entered the "danger zone." It will be clear that even with these limitations the family record is not complete. We should probably not err, if we supposed that on an average at least $\frac{1}{3}$ of a sibship affected with insanity in one of its members will be found insane on completion of the record. But a correction for the incompleteness of the family record, though far more necessary here than in the case of parental inheritance, has not been made, as it would lead us into too hypothetical a field. We content our-

selves by remarking that the fraternal correlation will probably come out too low, i.e. will have a minimum value on this account. Forming each pair of siblings out of our 315 families*, or $n(n-1)$ siblings for a family on n, we obtain Table XVI, as representing the uncorrected table, for tainted stocks only, in a symmetrical form.

TABLE XVI. *Incomplete Table for Fraternal Heredity. Tainted Stocks only.*

First Sibling.

Second Sibling.	Insane	Not Insane	Totals
Insane ...	250	1681	1931
Not Insane	1681	$6490+x$	$8171+x$
Totals	1931	$8171+x$	$10102+x$

Now assuming Table XVI to represent—what it does not do accurately—the full extent of insanity in tainted sibships, we have to add the pairs of siblings x due to untainted stocks in a random sample of this size. This is done as follows. Suppose y per cent. of the community are insane, then $404 \times \left(\frac{100}{y} - 1\right)$ would be the corresponding number of sane members. Of these 1433 are already included in our table as arising from the tainted stock. Hence corresponding to 404 insane we have $z = 404 \times \left(\frac{100}{y} - 1\right) - 1433$ individuals arising from sane sibships. Next, if we can assume that the fertility of the tainted stocks be not sensibly less than that of the sane stocks—which will be justified later—we have a rule of three sum to find the number of pairs of siblings which would arise from the above z individuals, for 1837 individuals gave rise to 10,102 pairs. Thus finally:

$$x = \frac{10102}{1837}\left(\frac{40400}{y} - 404 - 1433\right) = \frac{10102}{1837}\left(\frac{40400}{y} - 1837\right).$$

Putting y successively 1, 1·5 and 2, we obtain the Tables XVII, XVIII and XIX, which represent the distribution of pairs of siblings in the random samples of communities having the above percentages of "insane" members.

The values of the correlation for these fourfold tables were deduced in the usual way, leading to the following equations:

From Table XVII:

$$1{\cdot}888{,}709 = r + 2{\cdot}828{,}617r^2 + 3{\cdot}614{,}971r^3 + 1{\cdot}664{,}380r^4 + {\cdot}009{,}379r^5 + {\cdot}719{,}313r^6 + {\cdot}700{,}852r^7 + {\cdot}000{,}575r^8, \qquad r = {\cdot}51.$$

* Thus a family of ten with three insane, seven sane members, provides six pairs of siblings both insane, 21 pairs with first sibling sane and second insane, 21 pairs with first sibling insane and second sane, and 42 with both sane, or 90 sibling pairs in all.

From Table XVIII:

$$1{\cdot}347{,}845 = r + 2{\cdot}475{,}511r^2 + 2{\cdot}601{,}761r^3 + {\cdot}785{,}249r^4 + {\cdot}040{,}096r^5 + {\cdot}687{,}312r^6 + {\cdot}294{,}567r^7 + {\cdot}056{,}523r^8, \qquad r = {\cdot}47.$$

From Table XIX:

$$1{\cdot}055{,}187 = r + 2{\cdot}228{,}306r^2 + 1{\cdot}991{,}361r^3 + {\cdot}393{,}986r^4 + {\cdot}125{,}342r^5 + {\cdot}582{,}961r^6 + {\cdot}112{,}945r^7 + {\cdot}130{,}567r^8, \qquad r = {\cdot}44.$$

and if we extrapolate for a percentage of 2·5, we should have $r = {\cdot}41$.

TABLE XVII. *Complete Table for Fraternal Heredity. Tainted and Untainted Stocks. On 1 °/₀ Basis.*

First Sibling.

Second Sibling.		Insane	Not Insane	Totals
	Insane ...	250	1681	1931
	Not Insane	1681	218555	220236
	Totals	1931	220236	222167

TABLE XVIII. *Complete Table for Fraternal Heredity. On 1·5 °/₀ Basis.*

First Sibling.

Second Sibling.		Insane	Not Insane	Totals
	Insane ...	250	1681	1931
	Not Insane	1681	144498	146179
	Totals	1931	146179	148110

TABLE XIX. *Complete Table for Fraternal Heredity. On 2 °/₀ Basis.*

First Sibling.

Second Sibling.		Insane	Not Insane	Totals
	Insane ...	250	1681	1931
	Not Insane	1681	107472	109153
	Totals	1931	109153	111084

In dealing with pulmonary tuberculosis Pearson found that if the record of the tuberculous stocks was completed by allowing $\frac{1}{3}$rd instead of the recorded $\frac{1}{4}$th of the sibship to be ultimately tuberculous the value of the correlation was raised ·15. It is of very great importance that complete family records of insane sibships should be collected, giving the history of each member till death. In our incomplete records we find $\frac{1}{5}$th to $\frac{1}{4}$th insane, and although they are more complete than in the case of tuberculosis we have seen that the number of the insane is correlated with the age of the eldest member, and accordingly there is little doubt that the above values are too small. Probably the proportion of insane in the complete record would be at least $\frac{1}{4}$th to $\frac{1}{3}$rd of the sibship, and we might then fix the value of fraternal resemblance as lying according to the percentage assumed for the general population between ·45 and ·55.

The following table gives a general summary of results so far reached:

TABLE XX. *Fraternal Resemblance.*

Character	Source of Data	Computer	Intensity
Pathological:			
Pulmonary Tuberculosis	Crossley Sanatorium	Pearson	·48
Deaf-Mutism	Dr Fay's Data	Schuster	·73
Insanity	Dr Urquhart's Data	Heron...	·45—·55
Physical:			
Cephalic Index ...	Pearson, School Data	Lee and Pearson ...	·43—·54
Head Height	" "	" " ...	·49—·55
Stature	Pearson, Family Measurements	Pearson and Lee ...	·51—·55
Forearm	" " "	" " ...	·44—·51
Span	" " "	" " ...	·53—·56
Eye-Colour	Galton, Family Data	Pearson	·44—·52
Psychical:			
Intelligence	Pearson, School Data	Pearson and Lee ...	·44—·46
Handwriting	" "	" " ...	·48—·53
Intelligence	Oxford Class Lists	Elderton and Schuster	·52—·61

It will be seen that the resemblance in the case of the insane diathesis fits in well with the other data. The one really discordant result is that for deaf-mutism, which stands much above any value hitherto noted in the case of man*.

We may conclude that the resemblance of brothers in the character "insane diathesis" is, within the limits of incompleteness of record, well in accordance with the system of values found for other characters, whether physical or psychical.

* I have not succeeded in finding any important slip in Mr Schuster's analysis, but I note that he has based this part of his inquiry on the brothers and sisters of a *married* deaf-mute, which may to some extent have influenced selectively his result.

(8) *Fertility of Insane Stocks.* In 331 families or sibships* containing at least one insane member, the gross fertility distribution was found to be as follows:

TABLE XXI. *Fertility of Insane Stocks.*

Size of Family	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
No. of Families	16	48	44	34	51	35	39	39	21	11	11	6	6	1	1	1	331

The statistical constants of this distribution are as follows:

Mean Size of Family $= 5{\cdot}97 \pm {\cdot}11$.
Standard Deviation $= 2{\cdot}93 \pm {\cdot}08$.

The fact that insanity is a disease of adult life makes us fairly certain that the above families are practically completed. The stocks being middle class, we see at once that the fertility is high, and this is to be emphasised because no limit of duration of marriage has been taken, and no limit to the ages of parents upon marriage. Pearson, dealing with fertile English marriages, begun when both parents were at or under 35, and lasting at least 15 years has found an average gross family of 6·58, or only about half a child more than in the case of these marriages of insane stock, which may have, and undoubtedly have in certain cases, been started after 35 and have lasted less than 15 years. From the above result it will be clear that insane stocks are as fertile as and possibly more fertile than any other stocks in the community.

Even more important than the fertility of insane stocks is the fertility of marriages in which one parent has at one or other time been insane. From Dr Urquhart's data we find 87 such cases, in 48 of which the father, and 39 of which the mother, has been insane. The actual distribution of these 87 families is given in Table XXII:

TABLE XXII. *Fertility of Insane Persons.*

Size of Family	1	2	3	4	5	6	7	8	9	10	11	12	13
Frequency	5	13	9	14	12	8	8	4	5	7	—	—	2

From this we find:

Mean Size of Family $= 5{\cdot}18 \pm {\cdot}21$.
Standard Deviation $= 2{\cdot}84 \pm {\cdot}15$.

Now 5·18 is precisely the value found by Westergaard for the professional classes in Copenhagen in the case of marriages which have lasted *at least fifteen years* and for a race more fertile than the Scottish. We have also to remember (i) that the

* This word is used in the sense of groups of brothers and sisters the offspring of a single pair.

marriages of our insane persons have not been completed nor necessarily lasted even 15 years, (ii) that for a period, and in many cases a long period, the marriage has been interrupted by the confinement of one member in an asylum, and (iii) that the expectation of life of the insane is far less than that of the sane. Table XXIII gives the actual distributions for the purposes of comparison reckoned on the basis of 1000 individuals.

It will be seen that our present statistics amply confirm the general result reached by Pearson* that pathologically abnormal stocks, or stocks tainted by deaf-mutism, tuberculosis, albinism, mental degeneracy, criminality, etc., are not less but rather more fertile than the normal stocks in the community. The eugenic importance of this in

TABLE XXIII. *Comparative Fertility in Insane and Normal Stocks.*

Size of Family	Dr Urquhart's Data		Karl Pearson's Data		Copenhagen Data. Marriages of Professional Class lasting at least 15 years	Pearson, Peerage Marriages of at least 15 years
	Insane Stock	Insane Parent	Family Schedules	Marriages of 15 years begun at or before 35		
1	48	57	87	34	83	49
2	54	150	91	56	113	76
3	124	103	122	84	151	101
4	103	161	132	103	125	138
5	154	138	113	124	127	150
6	106	92	135	115	107	96
7	118	92	83	122	75	114
8	118	46	81	104	74	94
9	64	58	77	64	51	66
10	33	80	35	76	38	45
11	33	—	21	51	21	29
12	18	—	9	26	19	26
13	18	23	9	24	7	10
14	3	—	4	7	6	2
15	3	—	1	4	1	3
16	3	—	—	3	1	0
17	—	—	—	1	—	1
18	—	—	—	1	1	—
19	—	—	—	1	—	—
Total	1000	1000	1000	1000	1000	1000
Mean	6·0 ± ·11	5·2 ± ·21	5·3 ± ·07	6·6 ± ·06	5·2 ± ·05	5·8 ± ·07
Standard Deviation	2·93 ± ·08	2·84 ± ·15	2·87 ± ·05	3·06 ± ·04	2·99 ± ·04	3·14 ± ·05

relation to the insane diathesis is self-evident, for within the community natural selection is largely suspended, and the "insane" restored to family life as recovered. It would be of great value to have full statistics of the length and number of attacks

* See Pearson: *The Scope and Importance to the State of the Science of National Eugenics*, Boyle Lecture, Oxford University Press, Table IX, p. 35.

of the individual insane, so that some measure might be made of the population which fluctuates between the asylum and civil life. Full information will probably be only forthcoming when the General Register of the Insane referred to earlier in this paper is an accomplished fact.

(9) *Distribution of Insanity within the Sibship.* We now reach the investigation of a point not without difficulty, but of the greatest interest both from the standpoint of any theory of inheritance and from eugenic considerations. In tainted stock does the taint tend to become active in any correlation with the order of birth? According to the statistics of Pearson for tuberculosis and of Goring for criminality these pathological conditions are more evident in the earlier than the later born members of the stock. Does the like state of affairs exist in the case of insanity?

The point at which we have to be cautious is the doubt whether the apparent heavy incidence on the elder-born as compared with the younger-born is spurious and due to the fact that the population of the asylums is not a purely random sample of the general population. On the one hand the elder siblings reach the danger zone sooner than the younger, but as they pass through the asylum and die sooner than the younger it is not obvious that on this account we should expect to find in a given group of patients a larger proportion of elder siblings. In order to throw light, however, on this point, a correlation table was formed of the age of patients and their birth order in the family. The result was:

$$r = -\cdot 05 \pm \cdot 04.$$

If this were significant, the older the patient the slightly more likely he was to be born early in the family. But it is obvious that the correlation, having regard to its probable error, is of no significance, or that the age of the patient when the record was made had no relation to his order of birth. It does not therefore seem likely that the younger patients in the asylums represent a large number of early-born siblings just reaching the danger zone.

Taking any set of families in which at least one member of each family is marked with a certain characteristic, let there be f_s families of s members, s running from 1 to the maximum fertility p. In the f_s families of s, let F_s members be marked with the character in question. Then $f_1 = F_1$ and f_s will be equal to or greater than F_s.

Now if we assume that the marking is independent of the position in the family, we must have f_1 first born arising from the families of one. Of the F_2 marked individuals $\frac{1}{2} F_2$ will be first born and $\frac{1}{2} F_2$ second born; and generally the F_s marked individuals in families of s will provide F_s/s individuals in each birth position from 1 to s.

Accordingly the total number of first born will be $\sum\limits_{s=1}^{s=p} (F_s/s)$, and of qth born $\sum\limits_{s=q}^{s=p} (F_s/s)$.

Now let the total population consist of MN individuals made up of complete family groups. Then the number of first born will be $n_1 = \sum_{s=1}^{s=p} (f_s)$ and the number of qth born will be $nq = \sum_{s=q}^{s=p} (f_s)$. If M of the total population be marked with some characteristic which is independent of (a) size of family and (b) position in the family —that is, if all the MN are equally likely to be marked, then the number of marked first born is clearly n_1/N and of marked qth born n_q/N. Thus the distribution of order of birth among the marked population will be the same as that of the total population. But will the distribution of size of families be the same, if these families are selected by being the sibships of marked individuals? Clearly not, because large families will have more marked members and be more often likely to occur in the record, i.e. the large families are weighted in our returns, if we do not confine our attention to one member of each family. Analytically we can proceed as follows: taking the f_s families of s, there will be f_s/N tainted families and $f_s(1 - 1/N)$ untainted. The chance that no one member of a family of s members should be tainted is clearly $f_s(1 - 1/N)^s$, or the number of tainted members would be $f_s\{1 - (1 - 1/N)^s\}$. In other words this family would be reckoned this number of times, if we simply enquired as to size of family of each patient without investigating how far the patients were siblings. The distribution of the size of families would then be

$$f_1\{1 - (1 - 1/N)\} + f_2\{1 - (1 - 1/N)^2\} + f_3(1 - (1 - 1/N)^3\} + \ldots\ldots + f_p\{1 - (1 - 1/N)^p\},$$

and depend upon the extent of the marked character in the population. If the marked character be like insanity relatively rare, we may neglect $(1/N)^2$ and the distribution becomes

$$\frac{1}{N}(f_1 + 2f_2 + 3f_3 + \ldots + pf_p),$$

differing widely from the unselected distribution of $f_1 + f_2 + f_3 + \ldots + f_p$ by emphasising the large families.

This weighting of the large families when we select by a marking has been considered in another aspect by Pearson, namely in the inheritance of fertility, where the big families are emphasised in a random sample of the population, and in determining the real mean, the variability and the inheritance coefficient for fertility, allowance has to be made for it*. But this source of disturbance has no existence in our data if we confine our attention to distinct family histories and not to distinct insane individuals; the patient being the member of the sibship for whom the record was originally made.

The first point to be answered is: Does the distribution of siblings, i.e. frequency of first, second, third, fourth, etc. members of the family differ essentially in insane stocks from the distribution of normal stocks? Table XXIV gives the distribution

* Pearson, "Mathematical Contributions to the Theory of Evolution. VI. On Genetic (Reproductive) Selection," *Phil. Trans.* Vol. 192 A, pp. 261 et seq.

according to position in the family of 1000 individuals taken out of (*a*) families in the Peerage (Pearson), (*b*) insane stocks, (*c*) Pearson's selected marriages, i.e. those begun at or before 35 and lasting at least 15 years. It will be noticed that the average fertility of (*b*) lies between (*a*) and (*c*) and consequently we should expect (*a*) to have more elder and fewer younger sons than (*b*), while (*b*) would have more elder and fewer younger sons than (*c*).

A comparison of results shows us that there is nothing anomalous about (*b*); it may well be the distribution of offspring of any normal class of which the mean size of family is 6·0. Insane stocks as such seem to have no abnormal distribution of offspring. They form in themselves a proper norm to compare the distribution of

TABLE XXIV. *Distribution of Order of Birth in various Classes for a sample of* 1000 *individuals.*

Order of Birth	(*a*) Peerage	(*b*) Insane Stocks	(*c*) Selected Marriages	(*d*) Actually Insane
1	171·6	167·5	151·8	230·8
2	163·2	159·5	146·7	170·9
3	150·2	150·4	138·2	166·7
4	132·8	129·6	125·4	151·7
5	109·1	112·4	109·8	87·6
6	83·4	86·6	90·9	70·5
7	66·9	68·8	73·5	40·6
8	47·4	49·1	55·0	29·9
9	31·2	29·3	39·2	27·8
10	19·9	18·6	29·4	10·7
11	12·2	13·1	17·9	6·4
12	7·2	7·5	10·2	4·3
13	2·7	4·5	6·2	2·1
14	1·0	1·5	2·6	—
15	·7	1·0	1·5	—
16	·2	·5	·9	—
17	·2	—	·5	—
18	—	—	·3	—
19	—	—	·1	—

insane individuals with. We see at once from column (*d*) that this latter is of a wholly different character. The incidence of insanity is most heavy on the earlier born members of the family. The comparison of the distribution of order of birth among the insane members of insane stocks with the general distribution of all members of such stocks is made in Table XXV.

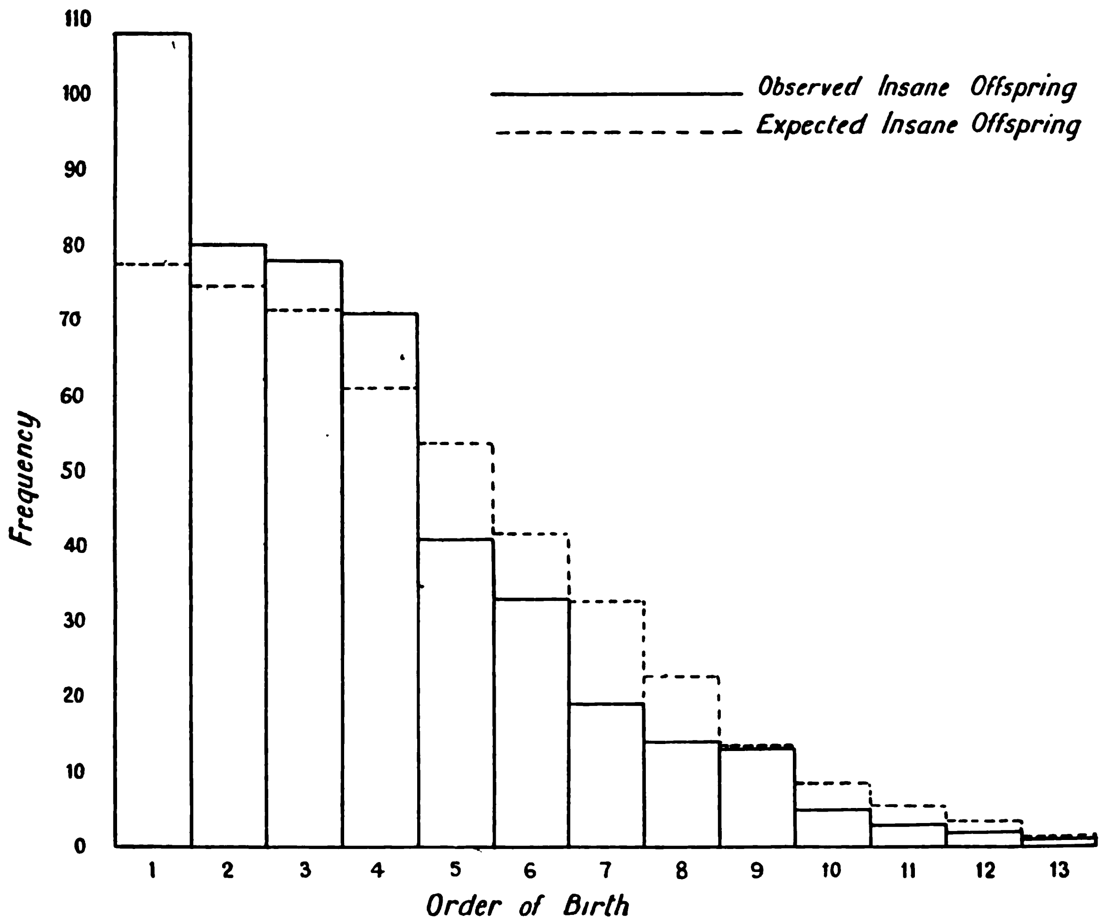
Thus the four eldest are in excess and all the others in defect among the insane. This anomalous condition is shown in the accompanying diagram. If we judge the matter analytically by calculating χ^2 to test the goodness of fit* we find $P = {\cdot}0013$, or the odds are nearly 1000 to 1 against the insane being a random sample from insane stock. We are compelled to suppose that insanity more often appears among the earlier born, corresponding in this respect to pulmonary tuberculosis and criminality†.

* *Biometrika*, Vol. I. p. 155. † Pearson, Boyle Lecture, p. 43.

If we suppose that the difficulty of the earlier labours, which is admitted, is in some way correlated with brain injury, it would be more natural to suppose it to lead to idiocy than insanity of the forms with which we are dealing. And the like cause would hardly explain the increased liability of the earlier born members of a family to pulmonary tuberculosis. Whatever may be the actual source of the matter, there appears now to be considerable evidence to show that pathological defect occurs more frequently in the earlier born members of a family than in the later members.

TABLE XXV. *Distribution of Siblings.*

Order of Birth	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Frequency, Insane Stocks	315	305	291	249	219	171	134	93	55	35	22	14	5	1908
Expected frequency of Insane Members	77·3	74·8	71·4	61·1	53·7	41·9	32·9	22·8	13·5	8·6	5·4	3·4	1·2	468
Actual Frequency of Insane Members	108	80	78	71	41	33	19	14	13	5	3	2	1	468
Defect ...	−30·7	−5·2	−6·6	−9·9	+12·7	+8·9	+13·9	+8·8	+0·5	+3·6	+2·4	+1·4	+0·2	—



(10) *Conclusions.* Data such as those on which this memoir is based are now being put on record in more than one asylum, and we may hope shortly for a considerable broadening of the basis upon which the present conclusions are built. But even with the present material, very definite statements can be made. There is a close correspondence between the inheritance of the insane diathesis and that of pulmonary tuberculosis. In fact it appears highly probable that the tendency to pathological defects generally is inherited in man in precisely the same manner as are physical and psychical characters. Further there is no reduction in, possibly rather an augmentation of, the fertility of insane stocks, when compared with that of sane stocks. The incidence of insanity does not appear to be equally distributed over the family, but to fall more heavily on the elder members. All these results are of vital importance from the standpoint of national eugenics. The tendency of pathological defect to be associated more intensely with the earlier born is a very strong argument against the restriction of the family. The normal, or probably more than normal fertility of the insane, notwithstanding their partial seclusion and high death-rate, and the fact that insanity is a disease largely of middle life, must make us pause before we acquiesce in the unrestricted return of the "recovered" insane to family life; while the definite inheritance of insanity which is here demonstrated, an inheritance as intense as that of deaf-mutism or the tubercular diathesis, must surely raise the question of the morality of the marriage and above all of the intermarriage of members of insane stocks. The time appears to be rapidly approaching when society to protect itself shall check by even more than moral condemnation the free marriage and unrestricted fertility of those of tainted stock.

Further it is needful to insist on the national importance of the problems here dealt with. That importance demands that a uniform and rational method of tabulating the facts as to the insane shall be instituted by law. And the first steps in this direction must undoubtedly be the compulsory notification of insanity and the formation of a General Register of the Insane. Only when this has been carried out can the real extent of the national taint and its true relationship to heredity, fertility, and environment be fully appreciated; only then can the proper remedies be devised for reducing this factor of national degeneracy.

In conclusion I should wish to acknowledge my indebtedness to Prof. Karl Pearson for much assistance during the course of the investigation.

APPENDIX.

EVIDENCE FROM FAMILY RECORDS.

The actual determination of the percentage of insane offspring of insane parents, can only be made when the offspring of insane parents have been followed completely through the danger zone. In the present memoir the number of insane offspring has had to be judged from the number of insane in the sibships of which one person is insane. The value of the percentage of the insane is therefore on this account exaggerated, as an insane parent might have all the offspring sane; but on the other hand it is minimised because at the time of the record the offspring of our insane parents are not wholly through, nay, many members have often not reached, the danger zone. Pearson's Family Records (Samples of General Population)* contain 17 cases of one or both parents being insane. There is only *one* family in this series in which all members lived to be 50 without a single case of insanity; thus it is very unlikely that the introduction of such families would sensibly affect the result given of 25 p.c. of insane offspring. Pearson's Family Records give 66 p.c. offspring insane where both parents are insane, 40 p.c. insane when one parent only is insane, and 44 p.c. insane when one or both parents are insane. In estimating these percentages, only those children surviving to 50 years of age without exhibiting insane tendencies are classed as sane. The average number of children per family who either became insane or lived sane to 50 is 4·6. These results, which will be ultimately more fully discussed when the Family Records are dealt with, appear to indicate that, if *completed* histories are taken, 40 p.c. of insane offspring of insane parents is not an over-estimate and that in this memoir we have erred on the side of lessening the intensity of inheritance in taking 25 p.c. of the offspring of insane persons to be insane.

* Using ancestral generations, where the bulk of individuals are dead or over 50 years.

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FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS. III

THE PROMISE OF YOUTH

AND THE

PERFORMANCE OF MANHOOD,

BEING

A STATISTICAL INQUIRY INTO THE QUESTION WHETHER SUCCESS IN THE EXAMINATION FOR THE B.A. DEGREE AT OXFORD IS FOLLOWED BY SUCCESS IN PROFESSIONAL LIFE

BY

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FELLOW OF NEW COLLEGE, OXFORD

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THE FRANCIS GALTON EUGENIC LABORATORY.

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Some reconstruction of the Francis Galton Laboratory having taken place, it seemed desirable to provide the workers associated with it with a direct channel of publication of their own, in which their more extended memoirs should appear. It is hoped that the present series may be issued at short intervals. Subscribers should notify their intention of taking in the memoirs as they are published to Messrs. Dulau & Co. Requests to exchange with similar publications, with archives and journals dealing with demographic and sociological problems, or with census reports, should be directed to The Editor, Eugenics Laboratory, University College, Gower Street, London, W.C.

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CONTENTS.

INTRODUCTION.

The question how far success at School and at the University is likely to be followed by success in the serious struggle of life is one of enormous practical importance. Many hundreds of thousands of pounds are spent annually in scholarships and exhibitions for the purpose of giving exceptionally able men the opportunity of securing a good education and a good chance in life. How far is this object accomplished? How far is the money wasted by passing to boys who appear abler than their fellows, merely because they have developed more rapidly, yet whose mental powers may be inferior to those of their rivals when both have increased to their utmost extent? But important as is the question in this relation, it is perhaps more important in the field of Eugenics, where any practical suggestion as to the means of securing a more rapid multiplication of the abler parts of the community must take the form of encouraging, in one way or in another, the marriages of those who have shown ability in boyhood or in early manhood. For it is to comparatively early marriages that one must look for large and healthy families, marriages of men who have not yet been tried in the fire of life, so that the only measure of their ability is the measure of their success in examinations at school and college. It is for this reason that it is important to know how far such success is a guarantee of mature ability; and as success in one's profession or occupation, though an imperfect measure of mature ability, is the only one we have, I have, in this paper, taken into consideration two professions, namely, the Bar and the Church, in which it is possible to obtain some official record of the degree of success of the various members, and dealing only with such among these as were educated at Oxford have endeavoured to determine how far officially recorded success is associated with success in the examination for the B.A. degree. In a previous paper written by Miss E. M. Elderton and myself,* we showed how the inheritance of ability from father to son can be demonstrated and to a certain extent measured by a statistical consideration of the Oxford class lists, and I shall adopt the same methods in the present paper to measure the heritage that the man receives from one who is proverbially his father, namely, himself in his boyhood.

Before going on to the description of the methods by which my tables are constructed, it will be necessary to give a short account of the history of the Oxford

* The Inheritance of Ability, *Eugenics Laboratory, Memoirs*, i. (Dulau & Co., Soho Square).

honours examinations. The following account, which is the same as that appearing in the paper above referred to, is condensed from that given on p. 191 of *The Oxford Historical Register*. It may be mentioned that practically all the people included in my tables took their degrees after the year 1830. From 1800-1806 the honours examination was conducted separately to the pass examination, the candidates were examined both in classics and mathematics, and there were two classes of honours, but during these years either very few people entered for honours or the standard was exceedingly high, for only fourteen men appear in either the first or second class. From 1807-1830 alternative subjects were introduced, namely, *Literæ Humaniores* or classics, and *Disciplinæ Mathematicæ et Physicæ* or mathematics; all candidates, whether for honours or no, were examined together, and there were in 1807-1808 two classes of honours, which were increased to three in 1809. In 1830 an extra class was added and those who were not candidates for honours were examined separately from those who were, but permission was given to the examiners to include in the fourth class honours list those candidates for the pass degree whom they thought worthy of it. This enactment came to an end in 1865, when the honours examination and the pass examination were allotted to different bodies of examiners. From 1830 onwards the four classes of honours have remained the same, although the number of subjects in which the examination is held has been greatly increased.

PART I.

THE CHURCH.

The basis of my work on this subject is Crockford's *Clerical Directory* for the year 1899. This volume is a biographical reference work of real merit; it contains, among other valuable features, a complete list covering over 1500 large octavo pages of the clergy of the Church in England, some 35,000 in all, and about each it tells their places of education, their degrees, date of ordination, also the curacies, livings, offices and dignities which they held or have held. My plan was to select from these all those Oxonians who were ordained deacons before the year 1874, and to class them first according to their degree of success as judged by preferment in the Church, and then further to subdivide them according to whether they had obtained first, second, third or fourth class honours, or whether they had obtained a pass degree or no degree. The reason why only those who took deacons' orders before the year 1874 were included is that a certain time had to be allowed to each man to obtain preferment in, and I judged that a man who was going to rise would, at any rate, have started on his upward path before he had been a parson for twenty-five years.

In my first classification a difficulty was met at the outset, namely, where to place the rather numerous tribe who take orders without becoming professional clergymen, but accept appointments as schoolmasters, dons, and so on. This difficulty is particularly great as these men are, judged by the class-list test, very superior to the majority of the rest, so that the way in which one treats them in making the tables would have a serious influence on the results obtained. Now it appeared to me that two alternative courses were open, either to exclude them altogether, or to divide them into two classes, an upper one, containing the headmasters of public schools, of the first-class grammar schools, the heads of houses at Oxford or Cambridge, the occupants of important professorial chairs, and so on; and a lower one, in which all the rest might be placed, namely, the headmasters of the second-class grammar schools, the assistant masters and housemasters at important schools, and all the rest who had adopted the scholastic profession without any very well-marked success in it; and having made these, to include the former in the tables under a separate heading, and to enter the latter in the same class with the ordinary "undistinguished" parsons. The former of these alternatives was not adopted, because it is an exceedingly difficult thing to draw a hard and fast line between the pro-

fessional clergy and the clerical schoolmaster, the same man frequently changes from one group to the other and back again to the first; headmasters become bishops, and assistant masters seek the leisure of a country parish; professors are sometimes canons, and curates become schoolmasters, so that it was thought better to avoid the difficulties of drawing this distinction and to fall back on the second alternative.

It was found that after omitting all those who were not Oxonians, or who were ordained after 1874, 3508 names were left, and it was thought that this number was sufficiently large to justify a division into two portions chronologically. Those who took their degrees in or before 1859, or, if they failed to take a degree, who took deacons' orders in 1860, were included in the earlier group (I.), and the rest were taken together in the later group (II.); of the whole number 3508, 2457 were undistinguished by any preferment, they were not bishops, archdeacons, deans, canons, prebendaries or rural deans, nor were they professional schoolmasters, although some of them might have done scholastic work for short periods. These were not all classified, but to save time a sample consisting of the first 1103 in alphabetical order was taken and analysed with the following results. 529 were found to belong to Group I., of whom 7 had obtained first class honours, 42 second class, 58 third class and 57 fourth class, 352 had obtained pass degrees and 13 were not stated to have obtained degrees. 574 belonged to Group II., and of these 15 had obtained first class honours, 55 second class, 68 third class, and 44 fourth class, 367 had obtained pass degrees and 25 were not stated to have obtained degrees. In making the tables it was necessary to multiply these numbers up in the proportion of 2457/1103, so as to make them correspond with the analysis of the "distinguished" class.

It is here perhaps as well to note that I use the word distinguished in a special sense, denoting by it all those not included in the class defined and subdivided above. I do not mean to imply that they all or even the majority of them are distinguished in the usual acceptance of the word, nor that all those included in the undistinguished class were in reality undistinguished. I am perfectly well aware that a full knowledge of the work of all those included would enable one to make a far juster and more valuable classification of success than that here adopted. But as I neither possess this knowledge nor the means of acquiring it, I was obliged to adopt the test of official position as being the only one available.

In Group I., that is to say among those who took their degrees in 1859 or previously, there were 581 men who were distinguished according to the special definition of distinction given above, of these 34 were bishops, 20 deans, 39 archdeacons, 211 canons and prebendaries, 158 rural deans, 27 with first class scholastic appointments and 92 with second class scholastic appointments; in Table I A. the degrees taken by each of these classes are summarised, except that the second class scholastic group is included with the "undistinguished" parsons. It will be seen from this table, that of the 34 bishops, 8 obtained first class honours, 2 second class, 2 third class, 4 fourth class, and 18 pass degrees; of the 20 deans, 6 obtained first

class honours, 4 second class, 1 fourth class, and 9 pass degrees; of the 39 archdeacons, 2 obtained first class honours, 9 second class, 6 third class, 6 fourth class, and 16 pass degrees; of the 211 canons and prebendaries, 28 obtained first class honours, 32 second class, 42 third class, 27 fourth class, and 82 pass degrees; of the 158 rural deans, 8 obtained first class honours, 18 second class, 18 third class, 19 fourth class, 92 pass degrees, and 3 are not stated to have obtained degrees; of the 27 headmasters, heads of colleges and professors, no less than 19 obtained first class honours, 6 second class, 1 third class and 1 a pass degree; of the remaining 1271, 33 obtained first class honours, 121 second class, 148 third class, 140 fourth class, 800 pass degrees, and 29 were not stated to have obtained degrees.

If we consider the table from the other point of view it will be seen that of the 104 men who obtained first class honours in the examination for the B.A. degree, 71 or 68 per cent. obtained either some clerical distinction or some first class scholastic appointment, while of the 192 second class men, 71 or only 37 per cent. obtained this degree of success, and the percentage falls farther to 32 per cent. among the third class men, 29 per cent. among the fourth class, 21 per cent. among those who took pass degrees, and 9 per cent. among those who took no degrees. These figures show at any rate that the chance of a successful career in the Church is very markedly greater for first class men than for second class, for second class than for third, and so on; but I have adopted two methods by which one can substitute for a series of percentages, such as is given above, a single number which is to be regarded as a measure of the causal relationship between the two variable factors which we are considering, namely, success in the examination for the B.A. degree and success in the Church. The two methods to which I refer are the "Contingency Method" and the "4 Square Correlation Method" of Professor Pearson; the former of these is fully described by him in the *Drapers' Company Research Memoirs* (Biometric Series, I. "On the Theory of Contingency and its Relation to Association and Normal Correlation") and the latter "On the Correlation of Characters not Quantitatively Measurable" (*Phil. Trans.*, Vol. 195, A, pp. 1-47). Two variations of the former method give two different results, called the "Mean Square Contingency Coefficient" and the "Mean Contingency Coefficient". Professor Pearson uses the symbols C_1 and C_2 to denote these two respectively, and these symbols will be used to save space and to avoid clumsiness of expression in the present paper. The letter "r" is usually used as a symbol for the correlation coefficient. Both C_1, C_2 and r may be considered as measures of causal relationship; they are all approximate to unity when this is complete and to nothing when this is non-existent. But when there is a partial relationship then it is only under certain circumstances that C_1 is equal to C_2, but when this is the case both are generally equal to r; when it is not the case, then, if the correlation method can be used, r forms the best measure of the partial causal relationship. C_1 and C_2 calculated from Table I A. are respectively ·41 and ·27, so the condition of agreement between

them does not obtain in the present case; the reason of the high value of C_1 appears to lie in the fact that owing to the nature of the material some parts of the table become too finely subdivided. It will be seen that in a large number of squares the numbers contained do not reach double figures, and owing to this the value of C_1 becomes too high, so that one would prefer to rely on the values of the correlation coefficient. In order to calculate the latter it is necessary to subdivide the table by a vertical and horizontal partition into four compartments; by doing so one divides the material in such a way that all contained above the horizontal partition have reached a higher grade of distinction in the Church than any of those below, whereas all to the left of the vertical partition have attained a higher degree of academic success than those to the right of it. In the three Tables I B., I C. and I D., those above the horizontal line are all who have attained any distinction at all in the Church or have obtained first class scholastic appointments, while those below are the "undistinguished" clergy and the second class schoolmasters and dons. A different vertical division is taken in each case; in I B. it comes between the honours men and pass men, in I C. between the third and fourth classes and in I D. between the second and third classes. The values for r obtained are ·30, ·32 and ·36 respectively. We shall see that the rise in the value of r as we divide the table more and more to the left is repeated in the tables dealing with the Church, Group II., and with the Bar. It is probably due to the fact that a certain number of men in the pass class were in reality at the time of degree taking quite as efficient mentally as those placed in the third and fourth classes, and thus the percentage of success among the pass men is higher than it would be if they had all been inferior to those in the fourth class. This circumstance by raising the number in the right hand top square of the correlation table reduces the value of r. If such men were transferred from the pass group to the classes in which they would have been placed had they tried for honours, then a certain number would have been transferred from the right hand top square of the table into the left hand top square and the value of r would have been raised. By shifting the vertical partition to a position between the third and fourth classes, as in Table I C., one renders it immaterial whether those men who took pass degrees, but who would have taken fourth classes had they tried for honours, are placed among the fourth class men or the pass men, and thus the value of r is raised to the same extent as if it had been possible to transfer them to Class IV. in Table I B. In the same way, shifting the vertical partition to a position between the second and third classes, as in Table I D., gives the same effect as would have been obtained by removing from the pass group not only those who would have been placed in the fourth class, but also those who would have reached the third, and putting each contingent into its proper place. Thus Table I D. gives a still higher rate for r than Table I C.; and doubtless a still higher value would have been obtained if it had been possible to divide the Table I A. between the first and second classes, and

yet leave enough individuals in each of the squares to give a reasonably probable result. Under these circumstances I think that of the five constants calculated, C_1, C_2 and the different values of r, most weight should be attached to the highest value of r. As will be seen when we consider Tables II A. and III A. exactly the same conclusion can be reached with regard to them, for the relative values of the five different constants obtained from Table I. are repeated in each of them.

Of Table II A. nothing much need be said; it was constructed in exactly the same way as Table I A., of quite independent material, and contains those men who took B.A. degrees between the years 1860-1874, or, in the case of those men who are not stated to have taken degrees, who had entered deacons' orders from 1861 to 1874. From it a value for C_1 of ·35 was obtained, and for C_2 of ·20. Tables II B., II C. and II D. correspond exactly to Tables I B., I C. and I D., and give values for r of ·24, ·28 and ·32. It will thus be seen that although the five constants calculated bear approximately the same relations to one another, as do the corresponding ones obtained from the earlier material, they are uniformly less, numerically. From this fact it might be argued either that intellectual merit has been recognised in the Church to a smaller extent during the last thirty years or so than formerly, or that the final examinations formed a less perfect test of such merit during the years 1860-1874 than during the preceding period. But a comparison of Tables I A. and II A. will show us that the probable explanation is different from either of these. It will be seen from Table I. that the "distinguished" number 489 out of 1760, or 27 per cent., during the earlier period, and from Table II., that during the later period they number only 346, or 19 per cent., so that we may conclude from this that twenty-five years was not long enough to allow for obtaining distinction, since the percentage of the distinguished is so much higher among those men who have spent approximately thirty-eight years or more in the Church, than among those who have only spent twenty-five to thirty-eight years, and I consider that this is probably the reason why the constants obtained from Table II. were of lower value than those calculated from Table I.

PART II.

THE BAR.

The only complete list of barristers which I could obtain, which gives their offices and achievements and which records their universities and degrees, was Joseph Foster's *Men at the Bar*, published in 1885. But the fact that this volume is out of date does not appear to me to impair its usefulness for my purpose, for if it is found that success in the schools at Oxford during the period dealt with indicated a real ability, which was afterwards rewarded by success at the Bar, it is probably as true that this is the case at the present day. Out of the list of persons contained in this work those were selected who had been educated at Oxford, and who had been called to the Bar before 1865, and had thus had twenty years of professional life in which to achieve some degree of distinction. These were then sorted according to the highest office which they had obtained. It is much to be regretted that no better criterion of distinction was available than a record of offices held, for although these offices are certainly an indication of success, yet by using them as the only test we are forced to include among the "undistinguished class" the really successful members of the junior Bar. It was found that there were in all 634 persons contained in the *Men at the Bar* who were qualified for inclusion in the tables, and I proceeded to make a somewhat detailed classification of these. In doing so much the same difficulty was encountered as in classifying the clergy, namely, that many men who were contained in the book were not practising barristers; it was met by including in the undistinguished class all of those who had not obtained real distinction in some other walk in life.

Of the 634, (I.) 6 had obtained first class appointments in political life, of whom 4 were Cabinet Ministers; (II.) 19 had obtained second class political appointments or had reached high rank in the Civil Service; (III.) 11 had become judges of the High Court or Law officers of the Crown; (IV.) 17 had become County Court judges; (V.) 38 were recorders or stipendiary magistrates; (VI.) 17 were Queen's Counsel but possessed no other office; (VII.) 18 were Indian or Colonial judges or had obtained political appointments in India or the Colonies; (VIII.) 9 held distinguished positions in the educational world; (IX.) 3 had obtained a considerable degree of fame as writers; (X.) 5 were chancellors of a diocese or vicars-general; (XI.) 8 were revising barristers. These numbers amount in all to 151, thus there were left 483 men in the "undistinguished" class.

In making the contingency table, it was not thought advisable to retain so many small groups as are enumerated above. So Group II. was joined to Group VII., Groups IV., V., X. and XI. were amalgamated, and so also were Groups VIII. and IX. The larger classes thus formed were analysed according to the position in the Oxford class lists of their members, and the results of both processes are recorded in Table III A.

It will be seen from this table that of the 92 first class men 42, or 46 per cent., attained some sort of distinction, and of the 85 second class men 28, or 33 per cent., attained the same amount; while of the 67 third class men 15, or 22 per cent., reached this grade; but after this the percentage does not sink so rapidly, there being 12 out of the 61, or 20 per cent., in the fourth class; 45 out of the 271, or 16 per cent., among the pass degree men, and 9 out of 58, or 15 per cent., among those who were not stated to have obtained a degree. The values of the statistical constants were as follows: C_1 ·40, C_2 ·34; and the three values of r obtained from Tables III B., III C. and III D., which correspond exactly to Tables I B. and II B., I C. and II C., I D. and II D., are respectively ·31, ·34 and ·38.

CONCLUSIONS.

It will now be useful to institute a comparison between the results obtained from our three sources of material, and for this purpose Table IV. has been drawn up. It has been argued that the correlation coefficients obtained by dividing the original tables between the second and third classes are the most reliable, and of these the result arrived at from the earlier group of clergy is more accurate than that given by the later. If we take these things into consideration we find that success both at the Bar and in the Church has a quite well-marked causal relationship with success in the Oxford final schools, and it is probable that if a better measure of success in these professions had been available, this relationship would have been found to be still more intimate. It may be that examination success is in some cases a direct help to preferment in the Church, but it cannot be asserted that it in any way influences the solicitors on whose good opinion of a man his success at the Bar is mainly dependent. Thus any selection based on the results of a fairly searching examination of men at the age of twenty-one to twenty-three would probably be on the whole a judicious one, though no doubt mistakes would be made in a certain percentage of cases.

One point more must be referred to. It is shown in the right-hand division of Table IV., that whereas 14·5 per cent. of the barristers were placed in Class I., only 5·9 per cent. or 6·2 per cent. of the clergy reached this standard. Thus there is reason to suppose that the Bar is a profession which attracts abler men than does the Church.

TABLE I A. *Degrees taken in* 1859 *and earlier*.

	Honours.				Pass Degree.	No Degree.	Totals.
	Class I.	Class II.	Class III.	Class IV.			
Bishops . . .	8	2	2	4	18	—	34
Deans . . .	6	4	—	1	9	—	20
Archdeacons . .	2	9	6	6	16	—	39
Canons and Prebendaries . . .	28	32	42	27	82	—	211
Rural Deans . .	8	18	18	19	92	3	158
Scholastic, First Class .	19	6	1	—	1	—	27
Scholastic, Second Class, and Undistinguished	33	121	148	140	800	29	1271
Totals . .	104	192	217	197	1018	32	1760

$C_1 = \cdot 41, \qquad C_2 = \cdot 27.$

TABLE I B.

	Honours, Classes I., II., III. and IV.	Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	268	221	489
Scholastic, Second Class, and "Undistinguished"	442	829	1271
Totals	710	1050	1760

$r = \cdot 30.$

TABLE I C.

	Honours, Classes I., II. and III.	Honours, Class IV. Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	211	278	489
Scholastic, Second Class, and "Undistinguished"	302	969	1271
Totals	513	1247	1760

$r = \cdot 32.$

TABLE I D.

	Honours, Classes I. and II.	Honours, Classes II. and III. Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	142	347	489
Scholastic, Second Class, and "Undistinguished"	154	1117	1271
Totals	296	1464	1760

$r = \cdot 36.$

TABLE II A. *Degrees taken in* 1860-1874.

	Honours.				Pass Degree.	No Degree.	Totals.
	Class I.	Class II.	Class III.	Class IV.			
Bishops . . .	5	9	6	1	12	—	33
Deans . . .	3	—	—	—	2	—	5
Archdeacons . .	1	8	7	2	11	1	30
Canons and Prebendaries . . .	11	33	15	6	50	2	117
Rural Deans . .	8	17	18	12	83	2	140
Scholastic, First Class .	14	7	—	—	—	—	21
Scholastic, Second Class, and Undistinguished .	67	155	177	106	840	57	1402
Totals . .	109	229	223	127	998	62	1748

$C_1 = \cdot 35$, $C_2 = \cdot 20$.

TABLE II B.

	Honours, Classes I., II., III. and IV.	Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	183	163	346
Scholastic, Second Class, and "Undistinguished"	505	897	1402
Totals	688	1060	1748

$r = \cdot 24$.

TABLE II C.

	Honours, Classes I., II. and III.	Honours, Class IV. Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	162	184	346
Scholastic, Second Class, and "Undistinguished"	399	1003	1402
Totals	561	1187	1748

$r = \cdot 28.$

TABLE II D.

	Honours, Classes I. and II.	Honours, Classes III. and IV. Pass Degree or No Degree.	Totals.
Bishops, Deans, Archdeacons, Canons, Prebendaries, Rural Deans and Scholastic, First Class	116	230	346
Scholastic, Second Class, and "Undistinguished"	222	1180	1402
Totals	338	1410	1748

$r = \cdot 32.$

TABLE III A.

	Honours.				Pass Degree.	No Degree.	Totals.
	Class I.	Class II.	Class III.	Class IV.			
Political Distinction (First Class) .	4	2	—	—	—	—	6
Political Distinction (Second Class), High Grade in Civil Service, Indian and Colonial Judges, etc. . . .	11	11	1	1	8	5	37
Judges of High Court or High Judicial Distinction	5	3	—	—	3	—	11
County Court Judges, Recorders, Stipendiary Magistrates, Chancellors of Dioceses and Vicars-General, etc.	5	8	11	8	32	4	68
Q.C.'s	8	2	3	3	1	—	17
First Class Educational Appointments or Literary Distinction	9	2	—	—	1	—	12
All Barristers not included in any of the above Classes	50	57	52	49	226	49	483
Totals	92	85	67	61	271	58	634

$C_1 = \cdot 40$, $C_2 = \cdot 34$.

TABLE III B.

	Honours, Classes I., II., III. and IV.	Pass Degree or No Degree.	Totals.
"Distinguished"	97	54	151
"Undistinguished"	208	275	483
Totals	305	329	634

$r = \cdot 31$,

TABLE III C.

	Honours, Classes I., II. and III.	Honours, Class IV. Pass Degree or No Degree.	Totals.
"Distinguished"	85	66	151
"Undistinguished"	159	324	483
Totals	244	390	634

$r = \cdot 34$.

TABLE III D.

	Honours, Classes I. and II.	Honours, Classes III. and IV. Pass Degree or No Degree.	Totals.
"Distinguished"	70	81	151
"Undistinguished"	107	376	483
Totals	177	457	634

$r = \cdot 38$.

TABLE IV.

Material.	Statistical Constants.					Percentages of the Six Different Degrees of Success obtained in the Oxford Examinations.					
	Mean Square Contingency Coefficient, C_1.	Mean Contingency Coefficient, C_2.	Correlation Coeff. obtained by dividing Table between Fourth Class and Pass Deg.	Correlation Coeff. obtained by dividing Table between Third and Fourth Classes of Honours.	Correlation Coeff. obtained by dividing Table between Second and Third Classes of Honours.	Honours, Class I	Honours, Class II.	Honours, Class III.	Honours, Class IV.	Pass Degree.	No Degree.
Clergy, earlier group	·41	·27	·30	·32	·36	5·9 ± ·54 *	10·9	12·3	11·2	57·8	1·8
Clergy, later group	·35	·20	·24	·28	·32	6·2	13·1	12·7	7·2	57·1	3·5
Bar	·40	·34	·31	·34	·38	14·5 ± ·94	13·4	10·6	9·6	42·7	9·1

* Since the number included in Table I. is not in reality 1760, but something like half this number, in calculating this probable error it has been assumed that the First Class men number 52 in 880, instead of 104 in 1760.

The difference between the percentage of First Class men among the barristers and among the clergy is 8·6 ± 1·09; as this difference is almost 8 times as great as its probable error it is almost certainly significant.

UNIVERSITY OF LONDON
FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS IV

ON THE MEASURE OF THE RESEMBLANCE OF FIRST COUSINS

BY

ETHEL M. ELDERTON,
GALTON RESEARCH SCHOLAR IN NATIONAL EUGENICS,
UNIVERSITY OF LONDON

ASSISTED BY

KARL PEARSON, F.R.S.

LONDON:
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1907

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THE FRANCIS GALTON EUGENICS LABORATORY.

University of London, University College, Gower Street, W.C.

The Laboratory is under the supervision of Professor Karl Pearson, F.R.S., in consultation with Mr Francis Galton, F.R.S.

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Some reconstruction of the Francis Galton Laboratory having taken place, it seemed desirable to provide the workers associated with it with a direct channel of publication of their own, in which their more extended memoirs should appear. It is hoped that the present series may be issued at short intervals. Subscribers should notify their intention of taking in the memoirs as they are published to Messrs Dulau & Co. Requests to exchange with similar publications, with archives and journals dealing with demographic and sociological problems, or with census reports, should be directed to The Editor, Eugenics Laboratory, University College, Gower Street, London, W.C.

On a Measure of the Resemblance of First Cousins in Man.

By Ethel M. Elderton, Galton Research Scholar in National Eugenics in the University of London; assisted by Karl Pearson, F.R.S.

1. *Introductory.* While a very large amount of data has been collected, reduced and published relating to the degree of resemblance in physical and psychical characters of a considerable number of pairs of relatives in man—especially in the direct line and between collaterals of the first degree—but little has yet been done with regard to collaterals in higher degrees. As far as we are aware the only quantitative measures yet determined are those for eye colour in man between uncle or aunt and nephew or niece*. No measure of resemblance has yet been determined for cousins. Yet it is precisely among collaterals of the second degree that the question of consanguineous marriages becomes in practical life of great importance, inequality of age being here less marked, and thus the degree of resemblance between such collaterals has not only scientific but eugenic value. According to local law and religious custom cousin marriages are permitted or forbidden; thus it would appear that we are here concerned with divergent human experiences, unconsciously formulated, as to the relative value of endogamy and exogamy. If we take a character which is detrimental to the individual, it will, at least in primitive communities, be in the bulk of cases a hindrance to mating. Hence, as a rule, we must classify such a detrimental character as recessive in the Mendelian sense†, otherwise selection would have weeded it out. Now consider for a moment a population of dominants with notation DD, and suppose one of these to mate with an individual of detrimental attribute and constitution RR. The result will be the hybrid sibship marked by DR, in which the recessive character R will be latent. If brother-sister mating is forbidden the next generation will be obtained (assuming the recessive individuals RR to be extremely rare) by mating with the population of dominant character, and the result will be equal numbers of DD and DR. Thus the generation of cousins would consist of 50 p. c. of dominants and 50 p. c. apparent dominants with the detrimental character recessive. It therefore follows that it would be as detrimental for *some* cousins to marry as for *all* brothers and sisters of the first hybrid sibship. That is to

* Pearson and Lee: *Phil. Trans.* Vol. 195, A, p. 114 *et seq.*

† Thus albinism and the tuberculous diathesis are, if not true and complete recessives in the Mendelian sense, still more nearly recessive than dominant characteristics. But there are other abnormalities, e.g. certain digital deformations, which are nearer to, if perhaps not true, dominants.

say while a brother and sister marriage would lead to 25 p. c. of the offspring having the harmful character patent and another 50 p. c. having it latent, the intermarriage of the cousins of the *DR* class among themselves would lead to the same baneful results as this brother-sister marriage, while the intermarriage of the *DR* class of cousin with the *DD* would also lead to 50 p. c. with the latent detrimental character. In other words endogamy as far as brothers and sisters are concerned would lead to:

25 p. c. hale. 50 p. c. latent evil. 25 p. c. patent evil.

while endogamy in the cousinship would give us:

56·25 p. c. hale. 37·5 p. c. latent evil. 6·25 p. c. patent evil.

The explanation therefore of the wide-spread social feeling against endogamy in the first degree, even between apparently hale individuals, is on the surface of it explicable on the Mendelian theory; also we see that, whether we look upon cousin marriage as producing on the average more than six per cent. of patent evil, or in the other aspect, that *some* cousin marriages are as detrimental as brother-sister marriages, reasons can be found for their all being forbidden by tribal custom or religious ordinance. But this is after all only to look on one side of the picture, because the *RR* characteristic might be a patent good quality suddenly introduced from outside into a population; in such a case cousin marriage is distinctly to be commended, and brother-sister marriage would be more effectual still. In this way the endogamy of many early communities receives its due sanction. As long as a species is likely to vary advantageously, endogamy between collaterals of the first degree will produce 75 p. c. with patent or latent good quality, and between collaterals of the second degree 62·5 p. c.*; even endogamy of ascendants and descendants may be advantageous. It is probable that whenever selection is extremely stringent the relative advantages of endogamy become apparent and are emphasised by tribal custom. But the Mendelian theory cannot be considered as demonstrated, and if it were, we could hardly at present apply it to man. We have no means of separating the *DR*'s from the *DD*'s, short of that experimental breeding which the Mendelians tell us is the only reliable guide to the gametic constitution. We cannot, however, afford to bring defective children into the world to test where the endogamous union will be an advantage, where a failure. The somatic characters of the individual and of his or her ancestry are at present our sole possible guide to his or her gametic constitution. From this standpoint we may ask what is the quantitative value of the cousin in the problem of inheritance? In predicting the probable offspring of an individual is the cousinship of more or less importance than the parents' brothers and sisters? Is a knowledge of the grandparents' characters of greater value than that of the cousin? It will be clear that the cousinship while generally less accessible than the sibship, is often far more accessible than the grandparentage, or in the case of orphans than even the parentage; and for the special purpose of medical diagnosis

* This supposes that endogamy in the first degree is forbidden.

may be of great relevance. The existing state of doubt as to the quantitative value of cousinship may be illustrated from such a vital problem as that of the hereditary predisposition to mental disease where some medical authorities would exclude entirely evidence drawn from the cousinship*, while they retain the inquiry as to the direct line and as to collaterals in the first degree. As the cousinship often combines many lines, it requires of course careful handling, but its size and relative accessibility may be factors which give it equal importance with the grandparentage or the parental sibships.

2. With the object of throwing light on the value of the record of cousinship, an inquiry as to the physical and psychological resemblance of first cousins was set on foot by Karl Pearson some five years ago and a grant obtained from the Government Grant Committee to assist the investigation. The assistance derived from this source is here gratefully acknowledged. The plan followed was twofold. Two independent collections were started. The first part of the investigation was based upon very general inquiries as to the physical and psychical characteristics of families. At present about 300 families have supplied very full particulars of ancestors and collaterals as far as the personal knowledge of the recorders extend. These Family Records supply the material upon which the bulk of the present paper is based, and provide sufficient pairs of cousins to give a fair idea of the general intensity of resemblance in cousins. The family schedules asked for the following information:

(1) Present Age or Age at Death of each individual.

(2) Ailments in Life.

(3) Cause of Death, if dead.

(4) General Health under the Categories: *Very Robust*, *Robust*, *Normally Healthy*, *Delicate*, and *Very Delicate*.

(5) Ability under the categories:

A.—*Mentally Defective.*—Capable of holding in the mind only the simplest facts, and incapable of perceiving or reasoning about the relationship between facts.

B.—*Slow Dull.*—Capable of perceiving relationship between facts in some few fields with long and continuous effort; but not generally or without much assistance.

C.—*Slow.*—Very slow in thought generally, but with time understanding is reached.

D.—*Slow Intelligent.*—Slow generally, although possibly more rapid in certain fields; quite sure of knowledge when once acquired.

E_1.—*Fairly Intelligent.*—Ready to grasp, and capable of perceiving facts in most fields; capable of understanding without much effort.

* Bucknill and Tuke: *Psychological Medicine*, 2nd edn. p. 266.

E_2.—*Distinctly Capable.*—A mind quick in perception and in reasoning rightly about the perceived.

F.—*Very Able.*—Quite exceptionally able intellectually, as evidenced either by the person's career or by consensus of opinion of acquaintances.

During a part of the investigation E_1 and E_2 were classed together as E, but a large number of D, E and E, F entries (i.e. 'Betwixt' entries) occurring, this category of E was divided as above into E_1 and E_2.

(6) Temper under the categories: *Sullen Temper, Quick Temper, Even Temper, Weak Temper* (not 'even,' but weak good nature).

(7) Temperament—under three divisions (*a*) *Reserved, Expressive* or *Betwixt*; (*b*) *Sympathetic, Callous* or *Betwixt*; (*c*) *Excitable, Calm* or *Betwixt.*

(8) Success in Life under the categories: *Marked Success*: An individual who is not only marked above his family, but above his fellow citizens for achievement in life. One who has made a name which would find a place in the *Dictionary of National Biography. Prosperous Career*: An individual who has advanced beyond his family level but not necessarily marked among his fellow men. An active successful life or career. *Average Career*: An individual who has not fallen below the family standard of life, whether in profession, trade or craft. *Difficult Career*: An individual who has found it difficult to maintain the previous family standard. One who has had a struggling and unprosperous career. *Failure*: An individual who has more or less failed in life; a bankrupt, or ne'er-do-well; this letter (F.) may be used to cover the black sheep of a family.

Considerable care was taken in distributing the schedules* among those likely to be interested in the investigation and having a sense of responsibility for the frankness and fullness of the information provided. A considerable number of schedules were returned to the recorders for corrections or additions which were at once supplied. In less than two per cent. of cases was it needful to reject a schedule as untrustworthy, or so incomplete as to be useless. Each Family Record contains on the average particulars of about 40 individuals and, as it is hoped to raise the total number of records from the present 300 to 1000, we shall then possess an account of a fairly random sample of the general population of about 40,000 persons.

3. The various types of cousinship distinguished in the schedules are: (*A*) Cousins are sons of two brothers. (*B*) Cousins are sons of two sisters. (*C*) Cousins are sons of a brother and a sister. (*D*) Cousins are daughters of two brothers. (*E*) Cousins are daughters of two sisters. (*F*) Cousins are daughters of a brother and sister. (*G*) Cousins are son and daughter of two brothers. (*H*) Cousins are son and daughter of two sisters. (*I*) One cousin is daughter of a brother, the other is son of a sister. (*K*) One cousin is daughter of a sister, the other is son of a brother.

* They provided for information with regard to four generations in the direct line, and three generations of collaterals.

A, *B* and *C* are types of male, *D*, *E* and *F* are types of female, *G*, *H*, *I*, *K* of male and female cousins. There are thus ten types of simple first cousins. It was considered desirable to keep these ten types distinct in order to ascertain how far resemblance was modified by change of sex in descent from a common ancestor. Special cases of abnormal cousinship in the first degree were not included. All individuals dealt with were adults. The four characteristics: General Health, Ability, Temper and Success in Life, providing 5, 7, 4 and 5 categories, admitted at once of tables of contingency being formed of at least 4×4 groups, and these were at once reduced by the method of mean square contingency. This was done for all the ten types of cousinship. In the case of Temperament there were only the alternatives and the 'Betwixt' groups. We were thus compelled to use either contingency on a 3×3-fold grouping or else assume the material to have a Gaussian distribution and apply fourfold table divisions. In the latter case the results will vary somewhat according to the alternative with which the 'Betwixt' group is associated.

The *Temperament* results are, however, in our opinion the least reliable of the series. We believe this to be due to the fact that the ability, success, health and to some extent the temper of an individual are matters of common knowledge or repute; but that temperament as we have classified it is less generally realised. There is little doubt that some of the recorders had not previously formed a general estimate of temperament, and have taken that of a particular individual as a standard to classify other members of the family by. We should not be inclined accordingly to place much stress on the Temperament results as proving anything beyond the basal principle that temperament is an inherited character.

In the second series of investigations, it was considered that it would not be without interest to deal with an entirely novel physical character, i.e. novel from the standpoint of inheritance, and accordingly the hand was selected as easily accessible and, at any rate for some characters*, capable of fairly accurate measurement. Other physical characters readily ascertainable were eye and hair colours and general health. Accordingly a cousin schedule was issued with the directions for measurement noted below. See Appendix A, p. 21. Much time and energy had already been spent over an endeavour to reproduce in a cheap manner the eye and hair scales used as standards in the Biometric Laboratory. Ultimately we had to content ourselves with an admittedly imperfect chromolithograph of hair colours†. For the eye scale we used a hand-painted scale. Miss Mary Beeton kindly painted on a printed blank the irides of 24 eyes, painting one eye at a time in about 100 copies from a standard glass eye. To these scales was added a cheap but quite efficient hand-spanner prepared by the Cambridge Scientific Instrument Company. The scales, spanners, directions and schedules were circulated in the same manner as the similar material

* *R. S. Proc.* Vol. 65, pp. 126—151: "Data for the Problem of Evolution in Man. A First Study of the Human Hand." By M. A. Whiteley and Karl Pearson.

† Reproduced *Biometrika*, Vol. v. p. 474.

for the Family Measurements of six years ago* : they were loaned to College students, personal friends of members of the Biometric Laboratory and others. It was, however, soon obvious that we had miscalculated the ease with which pairs of cousins could be found and measured. The work went forward extremely slowly, most investigators sent in only two or three pairs; and when the question of repeating or verifying a measurement arose, the delay or even the impossibility of supplementing the data was much more common than in the case of the Family Records. In fact cousins are not like brothers and sisters, or parents and offspring, in daily touch with each other; and at the end of three or four years, we are far from having reached a sufficient supply of cousin pairs. Hardly indeed have 300 pairs been yet measured. Accordingly this side of the enquiry is incomplete and will only be used as a control series. We need scarcely say that we shall be very glad indeed to loan spanner and scales to any reader of this memoir who will undertake to measure pairs of adult cousins.

4. We now turn to the analytical methods by which the material was reduced. We have already pointed out that contingency was used throughout the whole of the first series, but that in the case of Temperament the 3×3-fold tables were not finely enough grouped to make contingency thus obtained really comparable with that found from higher-fold tables. Accordingly the temperament tables were only worked out by 3×3-fold contingency in the case of the three groups: male cousin pairs, female cousin pairs, and male and female cousin pairs. The fourfold table method† was used on the same material in thirty cases, namely the three classes of temperament in the ten classes of cousins.

The mean value of the degree of resemblance between cousins as found from 40 contingency tables was $\cdot 271 \pm \cdot 009$ with a standard deviation of $\cdot 083 \pm \cdot 006$. The mean value of the degree of resemblance in temperament as found from 30 tables by fourfold process was $\cdot 258 \pm \cdot 014$, but the variability in this case was 35 p. c. greater, the standard deviation being $\cdot 115 \pm \cdot 010$.

The temperament tables worked by contingency with three types of cousins gave the result $\cdot 238 \pm \cdot 010$, with the reduced variability indicated by $\cdot 045 \pm \cdot 007$. These results are collected in Table I. They suffice to show that mean square contingency methods give more uniform results than the fourfold tables‡. But the mean found from contingency for *Health*, *Ability*, *Temper* and *Success* does not sensibly differ from that found for the three divisions of temperament by fourfold tables leading to the coefficient of correlation. If we combine the results of both methods so as to

* Directions and form of schedule for this case are reproduced in *Biometrika*, Vol. II. pp. 359–60.

† The fourfold tables were worked for two groupings for the alternatives *Excitable or Calm*; the *Betwixts* being thrown first into one group and then into the other, the average value of the correlation coefficient is that given in Table III. In the case of the alternatives *Reserved* and *Expressive* the *Betwixts* were thrown into the *Reserved*, and in that of the alternatives *Sympathetic* and *Callous* into the latter group. This was done after some consideration and enquiry as to the popular weight of terming an individual 'reserved' or 'callous.'

‡ The corresponding nine fourfold tables were somewhat erratic and gave a mean of only ·19.

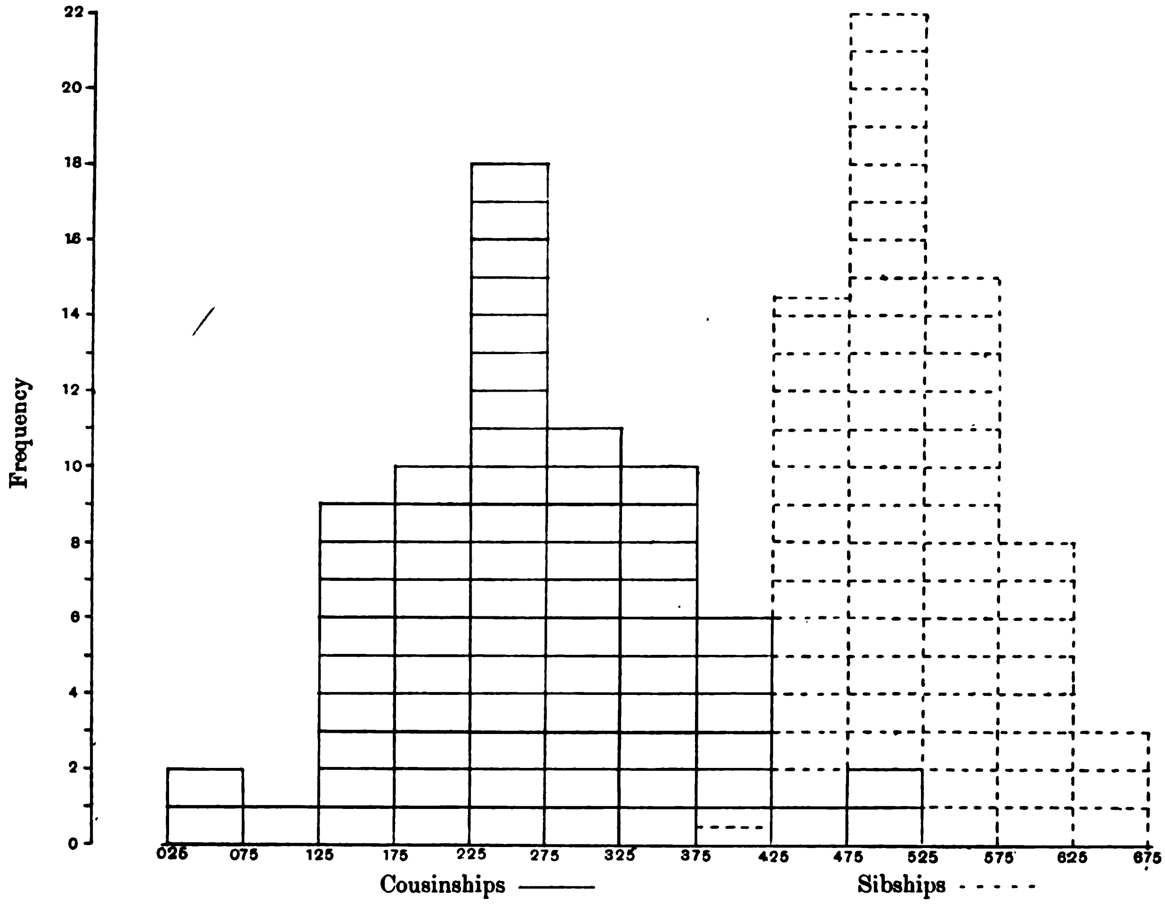
obtain a general average degree of resemblance between the ten types of cousins for seven characters, we find for the whole seventy tables:

Mean value ·267 ± ·008. Standard Deviation = ·093 ± ·006. Accordingly we may conclude that the average degree of resemblance of cousins lies between ·25 and ·30, say at ·27.

TABLE I. *Mean Results by Different Methods.*

Characters	Method	No. of Cases	Mean	Standard Deviation
Three Phases of Temperament	Fourfold Division	30	·258 ± ·014	·115 ± ·010
Ditto	Mean Square Contingency 3 × 3-fold Table	9	·238 ± ·010	·045 ± ·070
Health Ability Temper Success	Mean Square Contingency 4 × 4-fold and higher-fold Tables	40	·271 ± ·009	·083 ± ·006
Whole Series	Contingency Fourfold Division	40 30	·267* ± ·008	·093 ± ·005

Diagram of Frequency of Coefficients of Resemblance in Cousins and Brethren.



* Mean from grouped values; ungrouped value = ·265.

The fluctuation is no doubt considerable in our results. But we think that it lies far more in the difficulty of estimating psychical characters, than in any real variation in the degree of resemblance. The fluctuation is greatest precisely in those characters where personal bias and sex bias make the judgment more difficult.

We are now in a position to compare the intensity of resemblance between cousins with that between brethren. Diagram I, p. 9, shows graphically the distribution of the degree of resemblance of the 70 cases of cousins in this first series and of 65 cases of brethren, physical and psychical. The cases were numerically distributed as follows:

TABLE II.

	·025—·075	·075—·125	·125—·175	·175—·225	·225—·275	·275—·325	·325—·375	·375—·425	·425—·475	·475—·525	·525—·575	·575—·625	·625—·675	Totals
Cousinship	2	1	9	10	18	11	10	6	1	2	—	—	—	70
Sibship	—	—	—	—	—	—	2	·5	14·5	22	15	8	3	65

Mean Cousinship: $\cdot 27 \pm \cdot 008$. Standard Deviation: $\cdot 093 \pm \cdot 005$.
Mean Sibship: $\cdot 51 \pm \cdot 006$. Standard Deviation: $\cdot 068 \pm \cdot 004$.

An examination of the graph shows that the cousinship group clusters at ·25 and the sibship group at ·5. These may, we think, safely be taken as working values for cousinship and sibship resemblance for either sex, and we may safely assert that brethren are on the average twice as closely related as cousins. This halving of the degree of resemblance corresponding to the fact that normal first cousins have two common grandparents, whole sibs have four.

It must be noted: (*a*) that our data for cousins are not drawn from the same records as those for brothers and sisters. While the Family Records here used for cousins enable us also to deal with brothers, these have not yet been tabled and reduced, except in the one instance of *Intelligence*. Here the adult brothers gave ·54 as against the average of three cases of adult male cousins giving ·34. Schuster found ·56 from adult Oxford graduates for ability. Pearson found ·52 for brothers at school and Schuster for schoolboys ·56. The half of these fraternal values would be ·27, which agrees well with the general cousin average, but not so well with the ·34 which is a definitely higher value.

(*b*) that our data for cousins and sibs are neither from the same records, nor for the same range of characters. In the case of the sibships 21 values were for definitely measurable characters, a much more reliable class of material; while the cousinships of the first series do not present a single measurable character, and only one definitely physical estimate, that of Health. The characters which are common to

both series are: Health, Ability and Temper in adult cousins, and in sibships of school children; the following table gives the results for three classes:

TABLE II A.

Type	Intelligence		Health		Temper	
	Cousinship	Sibship	Cousinship	Sibship	Cousinship	Sibship
Male and Male	·34	·46	·31	·52	·18	·51
Female and Female	·34	·47	·33	·51	·19	·49
Male and Female	·34	·44	·30	·57	·25	·51
Mean	·34	·46	·31	·53	·20	·50

Mean Cousinship ·28. Half Mean Sibship ·25.

Treated alone these cases would show a definitely larger degree of resemblance for the cousinship, than for half the sibship, but this is not borne out for the whole material. The differences also of the ages of the subjects, adults and school children, and the methods of recording, by relatives and by school teachers, must also be borne in mind.

We consider on the basis of this first series that ·25 is a good round working number for the cousinship. This denotes on the assumptions of linear regression and the equal variability of the cousins, that *two* cousins of an individual selected from unrelated stocks (i.e. maternal and paternal cousins) will give the same probable value for the character of an individual, as a brother of that individual with the same character as the mean of the cousins*. On the other hand the accuracy of the estimate will not be so great. In the first case it is $\sigma_1\sqrt{1-(\cdot 5)^2}$ and in the second case $\sigma_1\sqrt{1-(\cdot 25)^2-(\cdot 25)^2}$, which measures the variability of the array; these are as 8·66 to 9·35. Thus the prediction from the brother would be somewhat better than from two mutually unrelated cousins. It is clear, however, that a knowledge of two such cousins may be very useful indeed, especially if facts as to the sibship are not forthcoming.

If we turn to other collateral relationships, the avuncular worked out for the eight possible cases in eye colour†, is, as far as we know, the only one yet published. The mean value of the eight cases is ·265. We should accordingly conclude from this that for purposes of inheritance a knowledge of the cousin is equally important with a knowledge of the parental sibships. For example, there is no justification in medical histories of lunacy for including the facts as to the parents' brothers and sisters and

* Regression equation for 1 on 2 and 3, the latter being independent, is

$$h_1 = \frac{r_{12}\sigma_1}{\sigma_2} h_2 + \frac{r_{13}\sigma_1}{\sigma_3} h_3 = r_{12}h_2 + r_{13}h_3, \text{ if } \sigma_1 = \sigma_2 = \sigma_3, \ = \cdot 50 \times \tfrac{1}{2}(h_2 + h_3), \text{ if } r_{12} = r_{13} = \cdot 25.$$

† *Phil. Trans.* Vol. 195, A, p. 114.

omitting the cousins from the record. On the same ground the marriage of niece or nephew with uncle or aunt seems to be a marriage of exactly the same degree of kinship as a marriage between first cousins.

The only grandparental data at present reduced for man* are those for eye-colour and the eight cases give a mean value of ·32†. This is somewhat higher than the value (·27) for cousins, and pigmentation data in horses have given an almost equal value. Still other species show rather smaller intensity, and until further data are reduced for the case of man, especially for psychical characters, we are not convinced that the grandparental relationship is definitely more important than the cousinship. At any rate, even with our present values (·27 as against ·32) it will be seen that it is not reasonable for the purposes of medical or actuarial diagnosis to neglect the cousins, and make a considerable point as to the grandparental constitution. The grandparent, the uncle or aunt and the cousin are practically on the same footing with regard to relationship or intensity of kinship as measured by degree of likeness of character; and it seems probable that any scientific marriage enactments would equally allow or equally forbid marriage between grandparent and grandchild, uncle and niece, aunt and nephew and between first cousins. This conclusion is reached on the assumption that the undesirability of marriage depends on the closeness of likeness in the gametic constitution, and that on the average the resemblance of the somatic characters may be taken as a measure of the average gametic resemblance between any two classes.

5. We now turn to the details of Table III.

We first ask whether there is any sensible difference between the intensity of inheritance in males and females. We note that the probable error of any individual result runs from about ·02 for cousins of same sex to ·03 for cousins of different sexes. Our table shows us that the average for pairs of male cousins is the same as that for pairs of female cousins, i.e. ·26. If we could lay any stress on the difference ·02, we should assert that cousins of different sexes were more alike than cousins of the same sex. But we certainly cannot, and thus, as far as our data go, we can only conclude that difference of sex makes no difference in degree of likeness.

In the next place we may consider whether type of cousinship makes any difference in the intensity of resemblance. Our mean values for all the characters range from ·22 to ·31 according to the type, and it might be thought that this offered sufficient range to answer the question. As defining the types there are two considerations to be noted, (i) a difference of sex in either generation, parental or cousinal, and (ii) a change of sex in descent. Neglecting the first we have:

No change of sex in descent in: A (·30), E (·27) or K (·29);

One change of sex in descent in: C (·23), F (·28), G (·24) or H (·31);

Two changes of sex in descent in: B (·24), D (·22), or I (·29).

* The Family Records of the present series provide unreduced material for seven characters, and this will shortly be dealt with.

† *Phil. Trans.* Vol. 195, A, p. 115.

The means for the three groups are ·287, ·265 and ·250 respectively. It may possibly be therefore that change of sex slightly weakens the intensity of inheritance in the stock. If we turn to the first consideration the change of sex in the same generation, the connected parents are of the same sex and the cousins of the same sex in *A* and *E*, but in *K* the connected parents are of different sexes and the cousins of different sexes. *K* is not, however, the least of the three. In *C* and *F* there is a

TABLE III. *General Results of First Series. Characters of Cousins.*

Type of Cousins	Health	Intelligence	Success	Temper	Temperament: Reserved or Expressive		Temperament: Sympathetic or Callous		Temperament: Excitable or Calm		Means
Method →	M.S.C.	M.S.C.	M.S.C.	M.S.C.	F.T.	M.S.C.	F.T.	M.S.C.	F.T.	M.S.C.	
Male. Type A	·34	·41	·24	·23	·38		·31		·21		·30
,, ,, B	·32	·30	·15	·16	·06	·20	·36	·24	·36	·34	·24
,, ,, C	·26	·32	·19	·15	·23		·30		·17		·23
Mean	·31	·34	·19	·18	·22	(·20)	·32	(·24)	·25	(·34)	·26
Female. Type D	·51	·34	·16	·14	·21		·03		·15		·22
,, ,, E	·24	·38	·27	·24	·30	·19	·42	·20	·04	·22	·27
,, ,, F	·23	·31	·35	·18	·26		·37		·23		·28
Mean	·33	·34	·26	·19	·26	(·19)	·27	(·20)	·14	(·22)	·26
Male & Female. Type G	·23	·36	·19	·20	·23		·22		·24		·24
,, ,, ,, H	·32	·27	·33	·30	·28	·24	·52	·24	·14	·28	·31
,, ,, ,, I	·29	·38	·27	·24	·22		·44		·16		·29
,, ,, ,, K	·37	·34	·26	·25	·42		·19		·18		·29
Mean	·30	·34	·26	·25	·29	(·24)	·34	(·24)	·18	(·28)	·28
General Means	·31	·34	·24	·21	·26	(·21)	·32	(·23)	·19	(·28)	·265

M. S. C. = Mean Square Contingency. F. T. = Fourfold Table.

difference of sex in the connecting parents, but not in cousins; in *G* and *H*, there is no difference in the connecting parents but one in the cousins. We might therefore expect no difference in the four values. But we find *C* and *G* contrasted in magnitude with *F* and *H*. In other words two males related by a male and female go with a male and female related by two males; and again two females related by a male and female go with a male and female related by two females. We can throw no light on this point, and it may only be a strange result of random sampling. In the third group there are no sex differences in the types *B* and *D* for either parental or cousinal generations.

For I there are such changes for both generations; and yet I is larger than B and D. We must thus consider that a difference of sex in the same generation makes no difference in the intensity of resemblance so far as our present data go. Accordingly, if change of sex in descent does to some extent weaken inheritance*, it does not appear connected with sex differences in the *same* generation. The differences noted are, however, too slender and the whole system of values too fluctuating to build up any hypothesis as to sex influence in heredity.

If we now turn to the separate characters, and compare irrespective of cousin type the general means of each, we find an even wider range of results (·19 to ·34). We attribute this only in part to real differences in the intensity of resemblance; we consider it more due to (*a*) difficulties of estimating some of the characters dealt with, especially as in the case of cousins they are usually not in daily contact with each other; (*b*) differences of method employed, and the assumption that temperament follows a normal distribution of frequency.

Accordingly we shall draw no conclusions as to divergences in resemblance, believing our data may be relied upon to give a "general average resemblance" of cousins, but cannot be pressed beyond such a result to discriminate between individual classes of character.

6. We now turn to the results of the second series of quantitative measurements. These measurements as we have already noted are far from complete. They give for the four measurements 107 pairs of female cousins, 34 pairs of male cousins, and 111 pairs of male and female cousins, the two first sets giving 214 and 68 pairs in the symmetrical table.

The following table gives the statistical constants of the series of measurements. It will be observed that we have two series for each sex, but not all the individuals in each series are different.

This table shows at once considerable irregularities, which may be due to the paucity of data, or to the defective handling of the spanners. While the finger joint measurements give a sex-ratio for the absolute lengths = ·91, very nearly the usual 11/12 of stature and of bone measurements in man, the widths of hand and wrist (involving a good deal more care in determination and allowing of more personal equation) give ratios of about 11·5/12. For these also the man is both absolutely and relatively more variable than the woman. For the joint measurements the woman is equally variable absolutely with the man, and relatively more variable. It seems improbable that this equal absolute variability is correct. It is not true for the majority of bone measurements in man and woman. It is further to be noted that in the Male and Female Cousins series, where there was a much larger return of measure-

* The influence of change of sex has been very elusive; it would appear to have some bearing on the inheritance of eye-colour in man (*Biometrika*, Vol. II. pp. 237–40), but we have failed to find it in coat-colour in horses (*Ibid.* Vol. II. pp. 229–34). It is doubtfully significant in the cases of coat-colour of Greyhounds (*Ibid.* Vol. III. pp. 257–8), and of Shorthorns (*Ibid.* Vol. IV. pp. 449–51).

ments made by male students than in the case of the Female and Female Cousins series, the absolute variabilities of the women are in every case *less* than in the latter series. In a certain number of cases it was actually found that the user of the hand-spanner had read from the sliding edge and not from the index point, but the difference amounting to about 20 mm. was obvious on the face of the measurements and at once allowed for by measuring the particular hand-spanner which had been used. It is believed that no residual error has crept in in this manner, but the point will be again dealt with below.

TABLE IV. *Statistical Constants of Measurements of Hand in Man and Woman.*

Sex	Series	Width of Hand			Width of Wrist			Joint, Index Finger			Joint, Little Finger		
		M.	S. D.	C. of V.	M.	S. D.	C. of V.	M.	S. D.	C. of V.	M.	S. D.	C. of V.
Male	Male with Male	83·2	6·20	7·45	58·2	3·90	6·70	62·5	2·87	4·59	51·0	2·72	5·33
„	Male with Female	82·1	5·77	7·03	57·9	4·17	7·20	62·0	3·23	5·21	50·9	3·01	5·91
„	Mean	82·6	5·98	7·24	58·0	4·04	7·00	62·2	3·05	4·90	51·0	2·87	5·63
Female	Female with Female	72·5	4·79	6·61	51·8	3·38	6·53	57·2	3·47	6·07	46·4	2·94	6·34
„	Female with Male	71·4	3·64	5·10	51·0	2·78	5·45	56·3	3·06	5·44	46·1	2·70	5·86
„	Mean	72·0	4·21	5·84	51·4	3·08	5·99	56·8	3·26	5·74	46·3	2·82	6·09
Sex Ratio, Male and Female		·87	·70	·81	·89	·76	·86	·91	1·07	1·17	·91	·98	1·08

The measurements are in mm.

The correlations as found by the product moment method without grouping are given in Table V. Now if we looked simply at the general mean ·336 of all 12 results, we might conclude that the intelligence and health characters of our first series had given us the more reliable results, the temperament and temper being more difficult of estimate, and thence conclude that the average resemblance of cousinship was 1/3.

TABLE V. *Correlation of Measured Characters in Pairs of Cousins.*

Character	Male and Male	Male and Female	Female and Female	Means
Width of Hand	·33	·21	·40	·314
Width of Wrist	·17	·26	·43	·286
Joint, Index Finger	·19	·34	·49	·340
Joint, Little Finger	·29	·37	·56	·404
Means	·245	·295	·470	·336

This view might be confirmed possibly by noting that the less easy measurements, those on hand and wrist, gave lower results than the joint measurements. But on further inspection of the table we notice that it is the female-female series which diverges so much from our previous results. The eight cases in which a male was one of the pair, and presumably worked the spanner, give a mean of ·270, agreeing excellently with the ·267 of our much larger first series. It is the pairs of female cousins, with their excessive variabilities, which give an intensity of resemblance equal to that of a sibship, and raising the average from ·270 to ·336.

To test the matter further the following steps were taken. A formula has been given by Pearson* which is based on normal distribution of frequency and gives the correlation coefficient in terms of the sum, $S(x-y)$, of the *positive* differences of correlated variates which have the same mean and S.D. Now this is precisely the case of the 106 cousin pairs if we treat them as a symmetrical distribution of 212 pairs. The formula is:

$$r = 1 - \frac{\pi \{S(x-y)\}^2}{N^2 \sigma^2}.$$

Applied to the data for the joint of the little finger in pairs of female cousins, we find $r = \cdot 5578$, while found by the product moment method the answer is ·5579, a very close agreement. But it will be clear that if the measurer had a personal equation of the nature of a constant error for each pair, it would drop out in the difference $x-y$ for that pair. Hence the formula above is convenient to use when such an error for the individual pair is suspected to exist, and the variability σ can be found from other considerations. If in this particular case we adopt: (a) the standard deviation of the women in the series of male and female cousins, (b) the standard deviation found for the women on the assumption that the coefficient of variation for the women ought to be (what it usually is) practically the same as for the men, i.e. if we take the two values 2·701 and 2·474, we find that the above formula gives $r = \cdot 48$ and ·38 respectively. Thus indicating some considerable reduction from the value ·56. It is therefore possible that an adding or subtracting of a constant difference in some of the measurements is the source of the exaggerated values of the female cousins resemblance. Such an error would not only have exaggerated the standard deviation, but it would have resulted at once, if a wrong correction had been applied to the measurements of those helpers who read at the edge, and not at the index point, of the spanner. It is believed that no spanners were removed from the numbered boxes until the measurements had been corrected; but the doubt, however slight, to those who had the control of the instruments, is sufficient to make it needful to repeat as soon as possible the whole series of measurements on female-female cousins.

We are able to use this second series as a control series also for the characters, hair colour, eye colour and general health. The method used was that of contingency

* "On further methods of determining Correlation," *Drapers' Research Memoirs*, Biometric Series IV. p. 4 *et seq.* (Dulau & Co., Soho Square).

but it must be remembered that the series were short, i.e. treated as symmetrical tables we had only 68, and 218 entries, and for male and female cousins 113. The results given in the following table were reached.

TABLE VI. *Non-quantitative Characters, Second Series.*

Character	Male and Male	Male and Female	Female and Female	Means
Health	·38	·29	·18	·282
Eye Colour	·44	·48	·38	·434
Hair Colour	·34	·26	·26	·286
Means	·386	·343	·273	·334

It will be seen at once that (i) the preponderating intensity of pairs of female cousins no longer exists, (ii) the eye colour values are, however, very high, in one case at least approaching the intensity of the resemblance of siblings, and (iii) the generally higher value obtained in the case of the measurable characters of the same series is maintained. We have already noted that eye and hair scales were used in these observations, 24 eye and 24 hair tints being given. There were 6 categories in the Health graduation, but the "Very Delicate" and the "Very Robust" categories were only very slightly represented, so that for Health merely 3 × 3-fold contingency tables,—"Robust," "Normally Healthy," "Delicate" seemed possible. For eye colour the 24 eye tints were first classed as "Pure Blue," "Blue with some orange," "Pure Grey," "Grey with some orange," "Hazel-Green," "Hazel-Brown," "Brown"; the two greys were then clubbed together, as also the two hazels to form a 5 × 5-fold table for contingency. The 7 × 7-fold table seemed far too fine for the numbers, 68, involved in the male and male cousin tables, and it was desirable to treat all three tables alike. The 24 tints of the hair scale were first grouped into: "Very Dark," "Dark-Brown," "Brown," "Light-Brown," "Fair," "Red." But for the male data only a single "fair" and a single "red" occurred and only three "browns." Accordingly the 2nd and 3rd categories and also the 5th and 6th were grouped together and a 4 × 4-fold table used for the contingency of hair-colour. As samples, the Eye and Hair colour tables for pairs of female cousins are given in Appendix B as Tables LXXX and LXXXI. Now while we frankly admit that this Second Series, whether of measurable or pigmentation characters, has a much too inadequate frequency to be conclusive, still its drift is undoubtedly to confirm the view, that the average resemblance of cousins is higher than that given by the Family Record results. It approaches nearer the value indicated by the more precise of the "Record" characters, and the more accurate of the hand measurements. The numbers in the first series are large as compared with those of the second, and the second series also involves several

points of doubt and difficulty; for this reason we have not yet modified the general average of the First Series by including these higher results. But it is conceivable that we may have to raise the general measure of resemblance of cousins from ·28 to ·33, when other large series already observed have been tabulated and reduced.

7. One further point may be finally touched upon, namely the inheritance of disease. We cannot in the least hope here for accurate numerical estimates, but the data of our first series may suffice to show that cousins are of value even from the standpoint of medical diagnosis. The difficulties of accurate determination are as follows:

(*a*) While on the schedules the record of brothers and sisters, of children, of parents and of grandparents is fairly complete, that of cousins must necessarily be defective. It is quite possible—nay not infrequent—to have more than 50 first cousins. And while one or two recorders actually were patient enough to enter details of a cousinship as large or even larger than this, the bulk of recorders contented themselves with entering a much more limited number, 10 to 12, and thus we have the first limitation; our cousins, as the recorders themselves state, are a *selection*. It is probable, also, that the selection has been made more frequently of living than of dead cousins, and more frequently of accessible than possibly inaccessible cousins; thus the individuals suffering from phthisis or insanity, or having died from these diseases, may without direct intention to deceive have been more frequently omitted than in the case of relatives *all* of whom were included.

(*b*) The cousins in our family record schedules are those of the subject. In order to get full ancestral information a young adult has been very often taken as the subject and the cousins belong accordingly to the third generation, and are themselves often young adults. It follows accordingly that their medical history is in many cases incomplete. They have not passed wholly through the danger zone in the case of either tuberculosis or insanity.

In the case of tuberculosis, we have for instance among males only 206 tuberculous out of 2990 individuals, and among females only 205 out of 3242, whereas 10 p.c. would probably be affected if we had the full record.

In our records for example there are in the case of women 130 cases of individuals classed as cousins with some form of brain disease or mental defect*. These 130 individuals have 6 insane and 124 sane cousins. If in the remainder of their lives 4 persons out of those 124 sane cousins were to suffer from some form of brain attack, then our table would be as follows:

* "Insanity" for the purpose of this investigation has been taken to include the neuroses: confirmed alcoholism and marked hysteria. These were not included by Heron in using Pearson's Family Records (*Eugenics Laboratory Publications*, II. p. 33). Its use here approaches "want of mental balance."

First Female Cousin

Second Female Cousin		Insane	Sane	Totals
	Insane	14	120	134
	Sane	120	2996	3116
	Totals	134	3116	3250

instead of the actual:

First Female Cousin

Second Female Cousin		Insane	Sane	Totals
	Insane	6	124	130
	Sane	124	2996	3120
	Totals	130	3120	3250

The fourfold table method gives the correlation of the first table about ·33 and that of the second ·03. Now it is not suggested that four additional cases of insanity are what we have to expect in the case of 124 persons chiefly young adults of insane stock. What we wish to point out is that with a disease *so relatively rare as this,* the transference when the record is completed of comparatively few individuals from the sane to the insane category is sufficient to raise the intensity of resemblance to a value quite equal to that which we have found for other characters in cousins.

The following are the results reached for insanity and tuberculosis:

TABLE VII. *Inheritance of Pathological Condition in Cousins with incomplete Record.*

	Male Cousins	Female Cousins	Male and Female Cousins	Means
Insanity	·18	·03	·08	·10
Tuberculosis	·07	·12	·19	·13
Means	·12	·08	·13	·11

In all six series—and they number in each case about 3000 pairs—we have a positive relationship, and the value is definitely significant in all cases but possibly that of insanity in female cousins. Yet this, owing to the fact that a considerable amount of insanity in the case of women is connected with change of life, is precisely what we might have anticipated considering the ages of our cousins. The fact also that insanity has a later average incidence than tuberculosis may explain why the average value for tuberculosis is higher than for insanity. We should conclude that so far as our data go they show that the tendency to both insanity and tuberculosis runs in stocks, and that with the incompleteness of the record there is no reason to

suggest that disease tendencies are not inherited at the same rate as physical and psychological characters in cousins.

8. *General Conclusions.* Our memoir has dealt with two series of cousin records. The quantitative measure of the resemblance of cousins is of great importance —not only on account of its bearing on eugenic marriages, but because cousins form often the principal living record to assist medical diagnosis. Its determination, however, presents considerable difficulties. It is not hard to collect data as to the characters of cousins, when these characters can be judged without the actual presence of the cousins. This was done in our first series. But when we come to the quantitative measurement of cousins our experience has been unfavourable to the rapid accumulation of extensive material. The passing from brethren to cousins—although the latter are a far wider group—has more than trebled the difficulty of obtaining measurements. Further our choice of the hand as the organ to be dealt with has possibly led to difficulty, as the treatment and use of the spanner needed more care than a simple measuring tape. It was possible to explain and illustrate the use of the spanner to all the male students to whom it was loaned, but in the case of women helpers we had often to trust to written directions. This *may* be the source of the high values found for the resemblance of women cousins, but we confess frankly that we are not satisfied that it is so, and we must await the reduction of further material before settling this point. If we turn to the 70 cases dealt with on the basis of our first series, we find an average resemblance of about ·27, which tallies with the average found from the eight quantitative series involving male cousins in our second investigation. If this value be confirmed we should say that cousins have as much significance as the parental brothers and sisters. On the other hand an examination of our table shows that what may be treated as the more easily judged and reliable results, show a rather higher value than ·27, approximating rather to the ·33 of the grandparental resemblance. The pigmentation results of the second series tend to confirm this view.

We should conclude accordingly from the present results that for the purposes of eugenics cousins must be classed as equally important with uncles and aunts, and that they may eventually turn out to be as important as grandparents. For practical purposes it would hardly seem possible in the matter of marriage restrictions based solely on the gametic resemblance judged by somatic characters, to differentiate between the three classes. This equality of resemblance which may appear at first sight paradoxical will be confirmed for uncles and aunts in a forthcoming memoir. Its physiological bearing appears to us of fundamental importance as indicating that a determinantal theory of heredity, emphasising alternate inheritance, must take precedence of any theory of simple blending for the bulk of the characters here dealt with.

We do not consider that our data show any difference between the inheritance of physical, psychical and pathological characters, which could not be accounted for by (*a*) the difficulty of appreciating temperament, and (*b*) the incompleteness of the cousin record.

APPENDIX A.

HEREDITARY RESEMBLANCE OF FIRST COUSINS*.

I. OBJECT OF MEASUREMENTS AND GENERAL INSTRUCTIONS.

I.—The present state of our knowledge of the laws of inheritance in man may be summed up as follows :—

We know well for a variety of organs direct inheritance from parent to offspring, and the collateral relationship between brothers and sisters. We have less complete, but still valuable data for the direct line in the case of grandparent and great-grandparents, and for the collateral line in the case of uncles and aunts. To supplement our knowledge, one of the most urgent problems is the determination of the degree of resemblance between cousins. It is with a view of solving this problem of cousin relationship that I appeal for cooperative observations and issue the present paper and schedules.

II.—For the purposes of the present investigation we are to understand by the word *cousin*:

(i) Full blood *First* Cousins, that is children of two whole (not half) brothers, of two whole (not half) sisters, or of a whole (not half) sister and brother. Such cousins are to have one and only one grandparental pair in common, and we term them *normal* cousins.

(ii) "Abnormal" first cousins are to be *excluded*.

It may happen that two brothers of one family have married to two sisters of another family, or that a sister and brother of one family have married a brother and sister of a second. The issue of such marriages are "doubly" first cousins having all their grandparents in common. Again, a brother and sister in one family might marry an aunt and a nephew in a second family, or again, might marry a woman and a man who are cousins in a second family, or, two brothers may marry two half sisters in a second family. Indeed cases of abnormal cousinship occur in which the abnormal cousins have 1, 2, 3 or 4 common grandparents. All such cases are excluded from the present investigation, which is concerned only with normal cousinship as defined under (i).

(iii) Normal cousins for the purpose of this investigation must be between 18 and 45 years of age.

* Issued by Professor Pearson, 1902 and onwards.

We cannot for a longer period consider the eye and hair colour to remain even approximately constant. With a shorter period we might fail to obtain sufficient material for statistical purposes.

III.—There are ten kinds of normal first cousins. Let A and B stand for the two cousins, thus:—

Two	A and B may be sons of two brothers.
Male	A and B may be sons of two sisters.
Cousins	A and B may be sons of a sister and brother.
Two	A and B may be daughters of two brothers.
Female	A and B may be daughters of two sisters.
Cousins	A and B may be daughters of a brother and sister.
Male	A and B may be son and daughter of two brothers.
and	A and B may be son and daughter of two sisters.
Female	A may be the son of a sister and B the daughter of a brother.
Cousins	A may be the son of a brother and B the daughter of a sister.

In this classification in the last group of "male and female cousins," A is taken as the male and B as the female cousin. But in the actual schedule provision is made for the case where the observer has taken A for the female and B for the male cousin.

The observer, after entering his or her own name, should fill in the names of the cousins A and B and their sex by putting a cross under male or female. Next, under type of cousinship, a cross should be put in the last column against the special type of the two cousins observed. This is very important, because we have reason to believe from the grandparental and avuncular relationships that the degree of resemblance varies a good deal with the type.

IV.—Any individual cousin A may be dealt with in any number of cases, but it is not desirable to compare one cousin A with more than four other cousins who are brothers and sisters to each other, and of these, not more than two should be of one sex. Subject to this limitation A may appear, or A's brothers and sisters, in any number of cousinships. A fresh schedule should be used for each such cousinship. It is not, however, necessary to fill in on these additional schedules all the measurements and characters. The name and sex only of the repeated cousin, and the type of cousinship, need to be inserted. A cross reference to the number of the observer's series in which the cousin is fully recorded will then suffice. A blank is left for this reference under the name and sex of cousin. For example, if P, Q, R, S be children of four different brothers and sisters, we first fill up a schedule of P and Q, then one of R referring to the schedule containing P; and another schedule referring to the schedule containing R and to the one containing Q, but giving the type of Q and R cousinship. Then we measure S and refer to P, and

finally two more schedules give merely the names of S and Q, and S and R with their types of cousinship, and refer to the proper schedules for the observations on S, Q and R. Or again, the observer may fill in one schedule for himself or herself, and then with simple reference to the number of that schedule and the type of cousinship, fill in separate papers for twenty or thirty of his or her cousins. Then another series of schedule papers may be filled with simple references to the individuals among these twenty or thirty persons (without repeating their measurements) who are cousins among themselves apart from their relationship to the observer. In each case the type of cousinship must be marked on the new schedule paper.

V.—Directions for recording Observations.

(1) *Hair Colour.*

On the hair-colour scale in the box, pick out the number of the hair corresponding most nearly to the colour under observation. If the hair considered falls between two tints, so exactly that you cannot say that it is nearer to the one than the other, give both tints, thus 5—6. If the hair has turned grey before 45, say so; and if the hair is of tint distinctly not on the scale, fasten a very small sample, sufficient to show colour, on the data sheet with the border of a sheet of postage stamp, or other strip of gummed paper.

(2) *Eye Colour.*

In judging eye colour, first fix the attention on the amount of orange-brown pigment in the iris. If there be no orange-brown pigment, the eye is (1) Dark Blue, (2) Blue, (3) Light Blue, (4) Light Grey. With hardly visible amounts of the orange-brown pigment we have next (5) Blue-green, (6) Dark Grey, (7) Hazel. Lastly, with clearly marked orange-brown pigment, we have (8) Light Brown, (9) Brown, (10) Dark Brown, (11) Very Dark Brown, (12) "Black." Samples of these eye types are given on the eye-colour scale. Look at the eye with the light upon it from a distance of about 18 inches and compare it with the scale. If the eye falls between two types on the scale, give the numbers of both types; if it agrees fairly well with any type, give the number of that single type only. Thus 6—7 would mean that the eye in question fell between 6 and 7 of the scale, but 7 would signify that it was closer to the 7 than to the 6 of the scale.

(3) *Health.*

Place a cross against the category under which the general health falls.

(4) *Measurements of Hand.*

These are to be made with the hand-spanner which will be found in the box. All the readings are to be taken to the *nearest* mark on the scale, and the observer need not give fractions of the units on the scale, if the length falls between two marks. If in any case the observer finds it quite impossible to determine which is the *nearer* mark, then give both units, e.g., 34—35.

Self-measurement of the LEFT HAND *by means of the hand-spanner.*

(i) *Width of Wrist.* See Figure (i).

Feel for and satisfy yourself as to the positions of the bony protuberances on either side of the main joint of the wrist. They are the sides of the ends of the two bones of the forearm. The space between the outer sides of these has to be measured with the spanner. Hold the spanner in the right hand, resting its fixed jaw against the breast, and manipulate the movable jaw with the spare fingers of the right hand. Lay the left wrist back upwards between the jaws of the spanner, so that the bony protuberances come against the jaws. Close the jaws with gentle pressure and clamp the movable jaw with the clamping nut underneath. Repeat this at least once, and if time will allow twice, taking the reading each time and entering it on the schedule. Do not be surprised if your measurements are not *exactly* the same. Only suspect something is wrong, if you find as much as two units difference in your results. If this be so, test carefully again. Do not fill in column marked "mean," but leave this to those who have to reduce the observations.

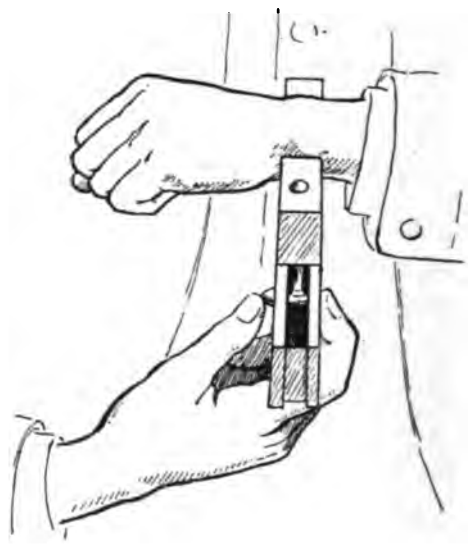


Fig. (i).

(ii) *Width of Hand.* (Left hand, as before.) See Figure (ii).

Feel for and satisfy yourself as to the positions of the outer sides of the knuckles, the one side being formed at the joint at the base of the little finger, the other at that of the forefinger. The hand is to be placed with the fingers close together, with the palm upwards, and *all the knuckles touching the spanner*. Measure the width between the outer sides with the spanner held with the fixed jaw against the breast and the scale horizontally upwards. Bring the movable jaw without pressure against the knuckle at the base of the forefinger. Clamp and read the scale. N.B.—Take care to make two or three trials.

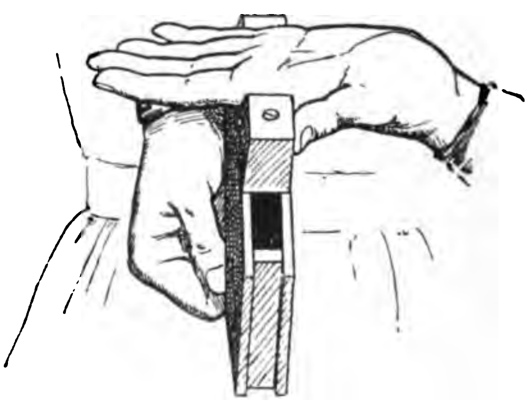


Fig. (ii).

(iii) *Length of First Joint of Index and Little Fingers.* (Left hand, as before.) See Figure (iii).

Close the fist (thumb outside) and measure in the same manner as in (ii),—thumb uppermost and spanner horizontal—the lengths from knuckle to first joint of (*a*) the Index Finger; (*b*) the Little Finger. The outside of first joint is put against the fixed jaw of the spanner, and the movable jaw is brought against the outside of the knuckle with gentle pressure. Clamp and read as before, making two or three trials.

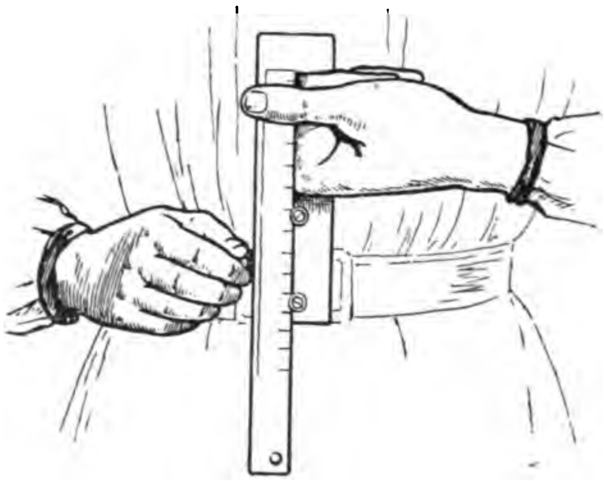


Fig. (iii).

All the measurements should be made with care. The above instructions are intended for self-measurement, but it is easy for one observer to measure both of a pair of cousins, or him or herself and then the cousin.

VI.—In case of any difficulty, please apply at once to Professor KARL PEARSON, University College, London, W.C. The Box and papers should not be kept longer than a month, unless the observer finds it possible to undertake a large series of cousins. About a thousand pairs of cousins of each type, 10,000 in all, will be required. Hence every co-operator will appreciate the necessity for rapid circulation of the boxes, of which only a limited number can be provided.

The name of the observer and address should always be given, in case it is necessary to ask questions as to any special measurement or observation. The cousins, if it be preferred, may be simply denoted by the initials of their christian and surnames, as these will suffice for the observer to identify them*.

* Spanners and schedules are still (November, 1907) being issued, and help in further cousin measurements will be gratefully accepted.

II. SCHEDULE.

Kindly make no attempt to fill this Schedule in until the General Instructions have been carefully read through.

Hereditary Resemblance of First Cousins.

Ages between 18 and 45.

Observer:

Name..........

Address..........

Number in Observer's Series	Number in whole Series*

* Leave this space blank.

Sex. (Place cross against Sex of Cousin.)

	Male	Female
Cousin A.		

	Male	Female
Cousin B.		

Name.......... Name..........

Type of Cousinship. (Place cross against type in right-hand column.)

Male Cousins	(i)	A and B are sons of two brothers	
	(ii)	A and B are sons of two sisters	
	(iii)	A is son of brother, B is son of sister	
		A is son of sister, B is son of brother	
Female Cousins	(iv)	A and B are daughters of two brothers	
	(v)	A and B are daughters of two sisters	
	(vi)	A is daughter of brother, B is daughter of sister ...	
		A is daughter of sister, B is daughter of brother ...	
Male and Female Cousins	(vii)	A is daughter, B is son of two brothers	
		A is son, B is daughter of two brothers	
	(viii)	A is daughter, B is son of two sisters	
		A is son, B is daughter of two sisters	
	(ix)	A is daughter of a brother, B is son of a sister ...	
		A is son of a sister, B is daughter of a brother ...	
	(x)	A is daughter of a sister, B is son of a brother ...	
		A is son of a brother, B is daughter of a sister ...	

* A's measurements are already given on Schedule No.	
B's measurements are already given on Schedule No.	

* *These are only to be used if A and B have already been scheduled for other pairs of cousinships.*

(1) Hair-Colour.

Insert number of nearest tint on hair-colour scale

A	B

(2) Eye-Colour.

Insert number of nearest tint on eye-colour scale

A	B

(3) Health.

Place a cross against the category which seems best to describe A's general health and a second in the last column for B's health.

	A	B
Very Robust ...		
Robust		
Normally Healthy		
Rather Delicate		
Delicate		
Very Delicate ...		

(4) Measurements of Left Hand.

To be made with the hand-spanner as described in the General Instructions.

Measurement	A				B			
	1st Trial	2nd Trial	3rd Trial	Mean*	1st Trial	2nd Trial	3rd Trial	Mean*
(i) Width of Wrist								
(ii) Width of Hand								
(iii) Length of First Joint, Index Finger								
(iv) Length of First Joint, Little Finger								

* This column is to be left blank.

To ensure accuracy it is desirable that two or three trials should be made of these measurements, if they are not taken by an independent observer who has measured already a considerable number of pairs.

Kindly return this Schedule when filled in to Professor Karl Pearson, University College, London, W.C.

APPENDIX B.

TABLES OF DATA.

HEALTH. MALE COUSINS.

TABLE I. *Type A.*

First Male Cousin (columns); Second Male Cousin (rows)

	Very Robust	Robust	Normally Healthy	Rather Delicate	Delicate	Totals
Very Robust	—	21	5	2	3	31
Robust	21	64	77	5	22	189
Normally Healthy	5	77	206	17	79	384
Rather Delicate	2	5	17	—	2	26
Delicate	3	22	79	2	26	132
Totals	31	189	384	26	132	762

TABLE II. *Type B.*

First Male Cousin (columns); Second Male Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	30	31	28	1	5	95
R.	31	98	77	5	25	236
N. H.	28	77	196	13	35	349
R. D.	1	5	13	—	2	21
D.	5	25	35	2	14	81
Totals	95	236	349	21	81	782

TABLE III. *Type C.*

First Male Cousin (columns); Second Male Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	18	52	45	2	18	135
R.	52	156	136	13	28	385
N. H.	45	136	314	15	70	580
R. D.	2	13	15	4	2	36
D.	18	28	70	2	28	146
Totals	135	385	580	36	146	1282

Health. Female Cousins.

Table IV. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	24	7	10	—	4	45
R.	7	44	99	5	48	203
N. H.	10	99	272	9	127	517
R. D.	—	5	9	8	3	25
D.	4	48	127	3	74	256
Totals	45	203	517	25	256	1046

Table V. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	—	6	15	—	6	27
R.	6	46	60	1	14	127
N. H.	15	60	200	4	78	357
R. D.	—	1	4	—	—	5
D.	6	14	78	—	22	120
Totals	27	127	357	5	120	636

Table VI. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	8	31	22	—	14	75
R.	31	66	123	1	66	287
N. H.	22	123	354	17	136	652
R. D.	—	1	17	—	2	20
D.	14	66	136	2	58	276
Totals	75	287	652	20	276	1310

Health. Male and Female Cousins.

Table VII. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	4	20	8	—	5	37
R.	10	66	85	12	27	200
N. H.	15	86	231	22	82	436
R. D.	—	7	10	2	2	21
D.	10	57	92	2	29	190
Totals	39	236	426	38	145	884

Table VIII. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	18	6	22	—	2	48
R.	19	52	45	2	21	130
N. H.	27	63	163	14	58	325
R. D.	1	3	4	—	1	9
D.	16	31	84	1	33	165
Totals	81	155	318	17	106	677

Table IX. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	8	8	13	—	6	35
R.	18	55	67	2	26	168
N. H.	17	82	217	13	38	367
R. D.	—	4	9	4	1	18
D.	7	33	55	2	18	115
Totals	50	182	361	21	89	703

Table X. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	V. R.	R.	N. H.	R. D.	D.	Totals
V. R.	14	13	9	—	5	41
R.	25	46	41	2	16	130
N. H.	11	95	219	18	47	390
R. D.	—	—	5	2	—	7
D.	17	34	81	1	24	157
Totals	67	188	355	23	92	725

INTELLIGENCE. MALE COUSINS.

TABLE XI. *Type A.*

First Male Cousin (columns); Second Male Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	14	42	36	5	97
E	42	208	55	14	319
E_1 & D	36	55	108	20	219
C, B & A	5	14	20	18	57
Totals	97	319	219	57	692

TABLE XII. *Type B.*

First Male Cousin (columns); Second Male Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	26	47	31	3	107
E	47	246	57	23	373
E_1 & D	31	57	54	19	161
C, B & A	3	23	19	6	51
Totals	107	373	161	51	692

TABLE XIII. *Type C.*

First Male Cousin (columns); Second Male Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	26	87	40	8	161
E	87	448	147	26	708
E_1 & D	40	147	118	30	335
C, B & A	8	26	30	30	94
Totals	161	708	335	94	1298

INTELLIGENCE. FEMALE COUSINS.

TABLE XIV. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	6	23	29	1	59
E	23	336	133	14	506
E_1 & D	29	133	198	37	397
C, B & A	1	14	37	8	60
Totals	59	506	397	60	1022

TABLE XV. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	8	9	17	1	35
E	9	262	97	22	390
E_1 & D	17	97	56	10	180
C, B & A	1	22	10	18	51
Totals	35	390	180	51	656

TABLE XVI. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	8	37	15	4	64
E	37	606	155	21	819
E_1 & D	15	155	160	24	354
C, B & A	4	21	24	8	57
Totals	64	819	354	57	1294

INTELLIGENCE. MALE AND FEMALE COUSINS.

TABLE XVII. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	11	30	15	—	56
E	69	266	60	34	429
E_1 & D	63	93	124	50	330
C, B & A	2	12	21	13	48
Totals	145	401	220	97	863

TABLE XVIII. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	13	46	12	2	73
E	29	279	74	20	402
E_1 & D	25	107	50	5	187
C, B & A	4	6	10	7	27
Totals	71	438	146	34	689

TABLE XIX. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	9	23	13	5	50
E	55	285	67	17	424
E_1 & D	22	60	77	9	168
C, B & A	4	14	12	13	43
Totals	90	382	169	44	685

TABLE XX. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	F & E_2	E	E_1 & D	C, B & A	Totals
F & E_2	17	23	9	1	50
E	34	334	93	19	480
E_1 & D	12	67	70	13	162
C, B & A	6	11	8	4	29
Totals	69	435	180	37	721

SUCCESS. MALE COUSINS.

TABLE XXI. *Type A.*

First Male Cousin (columns); Second Male Cousin (rows)

	Marked & Prosperous	Average	Difficult	Failure	Totals
Marked & Prosperous	39	102·25	27·75	15	184
Average	102·25	196·5	40·25	16	355
Difficult	27·75	40·25	28	6	102
Failure	15	16	6	10	47
Totals	184	355	102	47	688

TABLE XXII. *Type B.*

First Male Cousin (columns); Second Male Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	90	96	35	14·5	235·5
A.	96	139	47·5	14·5	297
D.	35	47·5	22	7	111·5
F.	14·5	14·5	7	8	44
Totals	235·5	297	111·5	44	688

TABLE XXIII. *Type C.*

First Male Cousin (columns); Second Male Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	79	147·75	47·25	26	300
A.	147·75	272	80·75	24	524·5
D.	47·25	80·75	51·5	6	185·5
F.	26	24	6	10	66
Totals	300	524·5	185·5	66	1076

Success. Female Cousins.

Table XXIV. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	21	59·75	6·25	—	87
A.	59·75	450·5	30·25	8	548·5
D.	6·25	30·25	—	—	36·5
F.	—	8	—	—	8
Totals	87	548·5	36·5	8	680

Table XXV. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	4	44	6	5	59
A.	44	227	27	6	304
D.	6	27	3	4	40
F.	5	6	4	4	19
Totals	59	304	40	19	422

Table XXVI. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	64	94	6·5	12	176·5
A.	94	604·5	33·5	4	736
D.	6·5	33·5	5·5	—	45·5
F.	12	4	—	—	16
Totals	176·5	736	45·5	16	974

SUCCESS. MALE AND FEMALE COUSINS.

TABLE XXVII. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	20	32·25	23·75	17	93
A.	104·5	224·75	83·75	43	456
D.	6·5	21	8·5	4	40
F.	4	1	—	—	5
Totals	135	279	116	64	594

TABLE XXVIII. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	23·5	24·5	5	11	64
A.	78·75	148·75	44	10	281·5
D.	6·25	21·25	24	6	57·5
F.	5	6	1	2	14
Totals	113·5	200·5	74	29	417

TABLE XXIX. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	20·5	35·5	31·5	9	96·5
A.	91·75	228·25	54·5	9	383·5
D.	8·75	9·25	5	—	23
F.	1	—	—	—	1
Totals	122	273	91	18	504

TABLE XXX. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	M. & P.	A.	D.	F.	Totals
M. & P.	38	24·75	12·75	9·5	85
A.	80·75	191·75	75	17	364·5
D.	5·75	7·5	5·75	1·5	20·5
F.	3	2	4	2	11
Totals	127·5	226	97·5	30	481

TEMPER. MALE COUSINS.

TABLE XXXI. *Type A.*

First Male Cousin (columns); Second Male Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	239	68	28·5	20·5	356
Quick	68	65	16·25	12·75	162
Sullen	28·5	16·25	6·5	3·75	55
Weak	20·5	12·75	3·75	4	41
Totals	356	162	55	41	614

TABLE XXXII. *Type B.*

First Male Cousin (columns); Second Male Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	202	84·5	17·5	17·5	321·5
Quick	84·5	29	9·5	7·5	130·5
Sullen	17·5	9·5	—	5	32
Weak	17·5	7·5	5	2	32
Totals	321·5	130·5	32	32	516

TABLE XXXIII. *Type C.*

First Male Cousin (columns); Second Male Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	419·5	179	43·5	24	666
Quick	179	96·5	22	17	314·5
Sullen	43·5	22	11	8·5	85
Weak	24	17	8·5	5	54·5
Totals	666	314·5	85	54·5	1120

Temper. Female Cousins.

Table XXXIV. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	361	118·25	61·25	18·5	559
Quick	118·25	77·5	27·75	8·5	232
Sullen	61·25	27·75	10	5·5	104·5
Weak	18·5	8·5	5·5	—	32·5
Totals	559	232	104·5	32·5	928

Table XXXV. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	269·5	75·5	16·5	6	367·5
Quick	75·5	64·5	7·5	4	151·5
Sullen	16·5	7·5	3	—	27
Weak	6	4	—	—	10
Totals	367·5	151·5	27	10	556

Table XXXVI. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	545·5	194·5	49·5	11·5	801
Quick	194·5	116·5	22	6·5	339·5
Sullen	49·5	22	4	6	81·5
Weak	11·5	6·5	6	—	24
Totals	801	339·5	81·5	24	1246

TEMPER. MALE AND FEMALE COUSINS.

TABLE XXXVII. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	265·5	98·5	50·0	23	437
Quick	104·25	72·25	29·0	19	224·5
Sullen	33	8·5	9·5	2	53
Weak	12·75	6·75	3	7	29·5
Totals	415·5	186	91·5	51	744

TABLE XXXVIII. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	206·5	74	25·5	25·5	331·5
Quick	89	49	26	7·5	171·5
Sullen	13·5	6·5	6	1	27
Weak	2	1	—	5	8
Totals	311	130·5	57·5	39	538

TABLE XXXIX. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	230	78	21	11·5	340·5
Quick	108·25	64·75	21	9·5	203·5
Sullen	14·25	10·75	4	2	31
Weak	6	5	—	—	11
Totals	358·5	158·5	46	23	586

TABLE XL. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	Even	Quick	Sullen	Weak	Totals
Even	273·5	65·25	20·75	12	371·5
Quick	100·25	61·25	11	14·5	187
Sullen	14·25	14·5	5·25	3·5	37·5
Weak	10	3	1	2	16
Totals	398	144	38	32	612

Temperament—Reserved or Expressive. Male Cousins.

Table XLI. *Type A.*

First Male Cousin (columns); Second Male Cousin (rows)

	Reserved	Betwixt	Expressive	Totals
Reserved	100	47	46	193
Betwixt	47	58	31	136
Expressive	46	31	68	145
Totals	193	136	145	474

Table XLII. *Type B.*

First Male Cousin (columns); Second Male Cousin (rows)

	Reserved	Betwixt	Expressive	Totals
Reserved	32	44	62	138
Betwixt	44	64	27	135
Expressive	62	27	50	139
Totals	138	135	139	412

Table XLIII. *Type C.*

First Male Cousin (columns); Second Male Cousin (rows)

	Reserved	Betwixt	Expressive	Totals
Reserved	202	105	107	414
Betwixt	105	108	68	281
Expressive	107	68	112	287
Totals	414	281	287	982

TEMPERAMENT—RESERVED OR EXPRESSIVE. FEMALE COUSINS.

TABLE XLIV. *Type D.*

First Female Cousin

Second Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	94	83	100	277
Betwixt	83	110	62	255
Expressive	100	62	122	284
Totals	277	255	284	816

TABLE XLV. *Type E.*

First Female Cousin

Second Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	32	34	53	119
Betwixt	34	74	50	158
Expressive	53	50	134	237
Totals	119	158	237	514

TABLE XLVI. *Type F.*

First Female Cousin

Second Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	86	111	117	314
Betwixt	111	120	110	341
Expressive	117	110	240	467
Totals	314	341	467	1122

Temperament—Reserved or Expressive. Male and Female Cousins.

Table XLVII. *Type G.*

Male Cousin

Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	87	50	53	190
Betwixt	57	87	41	185
Expressive	106	47	96	249
Totals	250	184	190	624

Table XLVIII. *Type H.*

Male Cousin

Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	26	26	27	79
Betwixt	72	69	33	174
Expressive	105	31	89	225
Totals	203	126	149	478

Table XLIX. *Type I.*

Male Cousin

Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	77	35	35	147
Betwixt	64	36	61	161
Expressive	100	29	105	234
Totals	241	100	201	542

Table L. *Type K.*

Male Cousin

Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	63	59	25	147
Betwixt	70	72	45	187
Expressive	71	27	83	181
Totals	204	158	153	515

TEMPERAMENT—RESERVED OR EXPRESSIVE. COUSINS. ALL TYPES.

TABLE LI. *Male Cousins.*

First Male Cousin

Second Male Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	334	196	215	745
Betwixt	196	230	126	552
Expressive	215	126	230	571
Totals	745	552	571	1868

TABLE LII. *Female Cousins.*

First Female Cousin

Second Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	212	228	270	710
Betwixt	228	304	222	754
Expressive	270	222	496	988
Totals	710	754	988	2452

TABLE LIII. *Male and Female Cousins.*

Male Cousin

Female Cousin	Reserved	Betwixt	Expressive	Totals
Reserved	253	170	140	563
Betwixt	263	264	180	707
Expressive	382	134	373	889
Totals	898	568	693	2159

TEMPERAMENT—SYMPATHETIC OR CALLOUS. MALE COUSINS.

TABLE LIV. *Type A.*

First Male Cousin

Second Male Cousin	Symp.	Betwixt	Callous	Totals
Symp.	91	28	2	121
Betwixt	35	36	5	76
Callous	31	15	2	48
Totals	157	79	9	245

TABLE LV. *Type B.*

First Male Cousin

Second Male Cousin	Symp.	Betwixt	Callous	Totals
Symp.	67	33	9	109
Betwixt	24	49	5	78
Callous	6	7	10	23
Totals	97	89	24	210

TABLE LVI. *Type C.*

First Male Cousin

Second Male Cousin	Symp.	Betwixt	Callous	Totals
Symp.	170	67	18	255
Betwixt	74	84	19	177
Callous	39	20	2	61
Totals	283	171	39	493

Temperament—Sympathetic or Callous. Female Cousins.

Table LVII. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	133	59	11	203
Betwixt	102	61	8	171
Callous	30	12	2	44
Totals	265	132	21	418

Table LVIII. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	151	40	7	198
Betwixt	26	27	1	54
Callous	15	7	7	29
Totals	192	74	15	281

Table LIX. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	321	82	14	417
Betwixt	53	46	6	105
Callous	25	11	4	40
Totals	399	139	24	562

Temperament—Sympathetic or Callous. Male and Female Cousins.

Table LX. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	257	113	42	412
Betwixt	85	87	25	197
Callous	28	9	2	39
Totals	370	209	69	648

Table LXI. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	205	91	15	311
Betwixt	41	92	12	145
Callous	13	4	12	29
Totals	259	187	39	485

Table LXII. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	293	66	43	402
Betwixt	50	53	16	119
Callous	11	8	3	22
Totals	354	127	62	543

Table LXIII. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	Symp.	Betwixt	Callous	Totals
Symp.	225	100	33	358
Betwixt	70	67	9	146
Callous	14	5	1	20
Totals	309	172	43	524

TEMPERAMENT—SYMPATHETIC OR CALLOUS. COUSINS. ALL TYPES.

TABLE LXIV. *Male Cousins.*

First Male Cousin

Second Male Cousin	Symp.	Betwixt	Callous	Totals
Symp.	656	261	105	1022
Betwixt	261	338	71	670
Callous	105	71	28	204
Totals	1022	670	204	1896

TABLE LXV. *Female Cousins.*

First Female Cousin

Second Female Cousin	Symp.	Betwixt	Callous	Totals
Symp.	1210	362	102	1674
Betwixt	362	268	45	675
Callous	102	45	26	173
Totals	1674	675	173	2522

TABLE LXVI. *Male and Female Cousins.*

Male Cousin

Female Cousin	Symp.	Betwixt	Callous	Totals
Symp.	980	370	133	1483
Betwixt	246	299	62	607
Callous	66	26	18	110
Totals	1292	695	213	2200

TEMPERAMENT—EXCITABLE OR CALM. MALE COUSINS.

TABLE LXVII. *Type A.*

First Male Cousin

Second Male Cousin	Excit.	Betwixt	Calm	Totals
Excit.	48	21	60	129
Betwixt	21	68	41	130
Calm	60	41	126	227
Totals	129	130	227	486

TABLE LXVIII. *Type B.*

First Male Cousin

Second Male Cousin	Excit.	Betwixt	Calm	Totals
Excit.	40	18	42	100
Betwixt	18	90	34	142
Calm	42	34	94	170
Totals	100	142	170	412

TABLE LXIX. *Type C.*

First Male Cousin

Second Male Cousin	Excit.	Betwixt	Calm	Totals
Excit.	78	56	122	256
Betwixt	56	166	93	315
Calm	122	93	224	439
Totals	256	315	439	1010

TEMPERAMENT—EXCITABLE OR CALM. FEMALE COUSINS.

TABLE LXX. *Type D.*

First Female Cousin (columns); Second Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	58	30	110	198
Betwixt	30	70	99	199
Calm	110	99	226	435
Totals	198	199	435	832

TABLE LXXI. *Type E.*

First Female Cousin (columns); Second Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	70	37	73	180
Betwixt	37	36	47	120
Calm	73	47	82	202
Totals	180	120	202	502

TABLE LXXII. *Type F.*

First Female Cousin (columns); Second Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	136	54	163	353
Betwixt	54	110	76	240
Calm	163	76	322	561
Totals	353	240	561	1154

TEMPERAMENT—EXCITABLE OR CALM. MALE AND FEMALE COUSINS.

TABLE LXXIII. *Type G.*

Male Cousin (columns); Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	45	39	81	165
Betwixt	12	70	54	136
Calm	47	82	163	292
Totals	104	191	298	593

TABLE LXXIV. *Type H.*

Male Cousin (columns); Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	48	26	76	150
Betwixt	31	87	66	184
Calm	42	31	70	143
Totals	121	144	212	477

TABLE LXXV. *Type I.*

Male Cousin (columns); Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	66	27	115	208
Betwixt	23	42	49	114
Calm	51	41	135	227
Totals	140	110	299	549

TABLE LXXVI. *Type K.*

Male Cousin (columns); Female Cousin (rows)

	Excit.	Betwixt	Calm	Totals
Excit.	44	21	87	152
Betwixt	18	65	32	115
Calm	60	50	152	262
Totals	122	136	271	529

TEMPERAMENT—EXCITABLE OR CALM. COUSINS. ALL TYPES.

TABLE LXXVII. *Male Cousins.*

First Male Cousin

Second Male Cousin	Excit.	Betwixt	Calm	Totals
Excit.	166	95	224	485
Betwixt	95	324	168	587
Calm	224	168	444	836
Totals	485	587	836	1908

TABLE LXXVIII. *Female Cousins.*

First Female Cousin

Second Female Cousin	Excit.	Betwixt	Calm	Totals
Excit.	264	121	346	731
Betwixt	121	216	222	559
Calm	346	222	630	1198
Totals	731	559	1198	2488

TABLE LXXIX. *Male and Female Cousins.*

Male Cousin

Female Cousin	Excit.	Betwixt	Calm	Totals
Excit.	203	113	359	675
Betwixt	84	264	201	549
Calm	200	204	520	924
Totals	487	581	1080	2148

Pigmentation Characters.

Table LXXX. *Eye Colour, Female Cousins.*

First Female Cousin (columns); Second Female Cousin (rows)

Tints	Pure Blue	Blue Orange	Pure Grey	Grey Orange	Hazel Green	Hazel Brown	Brown	Totals
Pure Blue	9	1·5	8	2·5	4·5	2·5	4·5	32·5
Blue Orange	1·5	6	7	9	3·5	3·5	8·5	39
Pure Grey	8	7	4	5	1	2	1·5	28·5
Grey Orange	2·5	9	5	6	1	6	2	31·5
Hazel Green	4·5	3·5	1	1	1·5	4·5	3	19
Hazel Brown	2·5	3·5	2	6	4·5	8·5	5·5	32·5
Brown	4·5	8·5	1·5	2	3	5·5	10	35
Totals	32·5	39	28·5	31·5	19	32·5	35	218

Table LXXXI. *Hair Colour, Female Cousins.*

First Female Cousin (columns); Second Female Cousin (rows)

Tints	Very Dark	Dark Brown	Brown	Light Brown	Fair	Red	Totals
Very Dark	9	11	3·5	11	1·5	—	36
Dark Brown	11	13	12	10	9	1	56
Brown	3·5	12	8	9·75	3·25	3	39·5
Light Brown	11	10	9·75	16·5	9·25	1	57·5
Fair	1·5	9	3·25	9·25	1	—	24
Red	—	1	3	1	—	—	5
Totals	36	56	39·5	57·5	24	5	218

PATHOLOGICAL CHARACTERS.

TABLE LXXXII. *Tuberculosis.*

Second Male Cousin / First Male Cousin

	Tuberculous	Non-tuberculous	Totals
Tuberculous	18	188	206
Non-tuberculous	188	2596	2784
Totals	206	2784	2990

TABLE LXXXIII. *Insanity**.

Second Male Cousin / First Male Cousin

	Insane	Sane	Totals
Insane	38	221	259
Sane	221	2510	2731
Totals	259	2731	2990

TABLE LXXXIV. *Tuberculosis.*

Second Female Cousin / First Female Cousin

	Tuberculous	Non-tuberculous	Totals
Tuberculous	20	185	205
Non-tuberculous	185	2852	3037
Totals	205	3037	3242

TABLE LXXXV. *Insanity**.

Second Female Cousin / First Female Cousin

	Insane	Sane	Totals
Insane	6	124	130
Sane	124	2996	3120
Totals	130	3120	3250

TABLE LXXXVI. *Tuberculosis.*

Female Cousin / Male Cousin

	Tuberculous	Non-tuberculous	Totals
Tuberculous	20	148	168
Non-tuberculous	237	2698	2935
Totals	257	2846	3103

TABLE LXXXVII. *Insanity**.

Female Cousin / Male Cousin

	Insane	Sane	Totals
Insane	12	128	140
Sane	187	2791	2978
Totals	199	2919	3118

* Includes marked neuroses, alcoholism and hysteria.

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A FIRST STUDY OF

THE INHERITANCE OF VISION

AND OF THE RELATIVE INFLUENCE OF HEREDITY AND ENVIRONMENT ON SIGHT.

BY

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WITH ONE PLATE
AND THREE DIAGRAMS IN THE TEXT

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CONTENTS

A FIRST STUDY OF THE INHERITANCE OF VISION, AND OF THE RELATIVE INFLUENCE OF HEREDITY AND ENVIRONMENT ON SIGHT.

By AMY BARRINGTON and KARL PEARSON, Galton Eugenics Laboratory, University of London.

(1) *Introductory.* According to Mr Galton's definition of the science of National Eugenics, this new study is concerned with the influence not only of nature but of nurture on racial qualities. In seeking to illustrate the relative intensity of the two factors, heredity and environment, it occurred to us that eyesight might form a suitable character for investigation. We must at once confess that the suitability in question arose from the subject matter and not from the investigators. As our attempt may appear over bold to the specialist in the field of ophthalmology, we must briefly state the reasons for our selection of this topic. In the first place a relatively large amount of data, wholly unreduced from the standpoint of modern statistics, was available. In the second place much of this material was associated with observations of home and school conditions which would possibly throw light on the influence of the environment factor. Thirdly we found a large number of statements as to age, town and school surroundings, heredity and home, which are doubtless more or less accurate, but appear to have been given hitherto no quantitative relationship, and to be occasionally wanting in adequate statistical basis. From this standpoint the material possessed considerable fascination for the student of modern statistical methods. Lastly while much of the data bearing on other human characters has been collected by the layman, the measurement of vision has been, owing to its practical importance, a favourite study of the medical expert. This advantage, however, is accompanied by the inconvenience, that our material is drawn rather more from abnormal than normal sources.

In dealing statistically with the data available we have endeavoured to avoid gross blunders of interpretation by appealing for technical knowledge to specialists. Among these we have in the first place to thank Mr E. Nettleship for his ready answers to many questions placed before him, and for his copious references to ophthalmic literature; it is, perhaps, needless to add that he is in nowise responsible for any conclusions drawn or opinions expressed in this memoir, the data and methods of which were only placed before him for his ever useful and friendly criticism after the completion of the manuscript.

(2) *Material.* The scope of this memoir being twofold, we turned first to the question of heredity and sought for the best material available on the inheritance

of visual characters. This must be sought for in two directions: vision of the adult and vision of the child. While much information as to the latter can be gained from the reports of medical officers of schools, we must trust for the former to the work of the ophthalmic surgeon in hospital or private practice.

The most complete statistical results that we have found from this side are due to Dr Adolf Steiger of Zürich. In 1895 he published:

(A) *Beiträge zur Physiologie und Pathologie der Hornhautrefraction.* 1. Theil (Wiesbaden, Bergmann),

and in 1906–7 a memoir:

(B) *Studien über die erblichen Verhältnisse der Hornhautkrümmung* in Kuhnt and Mechel's *Zeitschrift für Augenheilkunde*, Bd. XVI. S. 229–42, S. 333–59, Bd. XVII. S. 307–17, 444–59.

Steiger in his memoir goes so far in modern statistical methods as to give correlation tables and even "fourfold" tables and uses them to insist in a general way on the inheritance of corneal refraction. He has not, however, applied modern notions of correlation, and his methods of grouping are occasionally such as to give considerable trouble to the statistical investigator.

At the very outset also we are encountered by the difficulty that his material is intensely selected. The normal individual is most inadequately represented, because in most cases one or other member of the related pair came to the ophthalmic surgeon on account of defective vision. This statement is not made in order to detract from the great merit of Steiger's work, but to guide our judgment in forming conclusions when we come to interpret the statistical constants. Indeed the fact that Steiger's material for adults is not a random sample of the population would we believe be at once admitted by him*. The defect is one which is common to all medically collected data, and we can only place against it the greater accuracy attained by a prolonged and careful examination of the individual by a first class specialist. Unfortunately we have in this case no means of supplementing Steiger's material by a general knowledge of the distribution of astigmatism and corneal refraction in the community at large. We must simply recognise that we are dealing with heredity in highly selected material.

Steiger deals not only with material from his private practice, but with observations of Swiss school children. With regard to school children elsewhere the reports we have used are:

(C) *Errors of Refraction among Children attending Elementary Schools in London.* By A. Hugh Thompson, M.A., M.D. (London, Bale, reprinted from the *British Medical Journal.*)

Dr Thompson's conclusions as to the influence of age on refraction and astigmatism may be correct, but they are not demonstrated by the statistical method he has employed. He has found that among children of defective vision, the relative

* Mein Material wurde eben nicht zu dem ausgesprochenen Zwecke gesammelt, die hereditären Verhältnisse zu studiren, (B) Vol. XVII. p. 454.

percentage of myopic children increases with age. It does not necessarily follow that there is an increase of myopia with age; we require first to know whether the number of children with defective vision is the same at each age, and no data for answering this question is provided in the paper. It is in fact the old story, the absence of the distribution of the normal children renders the conclusions of little value. We shall discuss below what further data we have been able to find on the relation of vision to growth and age in children.

(D) *Eyesight of School Children. Report on the Examination of the Eyes of Five Hundred Children in the Glasgow General Assembly Normal Practising School.* By John Rowan, M.B. *The Educational Times*, April, 1906.

This paper deals with normal as well as defective vision, and the group of children may be taken as a fairly random sample of a Scottish urban primary school. Dr Rowan deals with acuteness of vision as well as refraction. He has formed a list of diseases and taken the colour of the iris. He has not, however, given the data by which we might determine whether there is any correlation between colour of iris and eyesight.

(E) *Report of the Education Committee to the London County Council*, 1904, p. 31 et seq.

This gives the relation between age and acuteness of vision for 10,469 boys and 10,275 girls (p. 32) and more roughly for large series on p. 33. We have only used the former series, as the latter do not lend themselves to contingency calculations, the acuteness of vision being only classed as "good," "fair," and "bad."

(F) *Report on the Physical Condition of Fourteen Hundred School Children in the City together with some account of their Homes and Surroundings.* City of Edinburgh Charity Organisation Society. (King, London, 1906.)

This appears to be a thoroughly reliable, well designed and well executed piece of work, providing a rich quarry for the student of Eugenics. Very little reduction is made of the immense mass of material, and our present correlation investigations deal with only a relatively small part of what we hope to ultimately publish from this source. While exception may possibly be taken to this or that feature of the work, we know no collection of data which covers the same ground, or is on the whole so statistically self-consistent as that contained in this Report. It will always be easy to criticise "appreciations" and "qualitative statements," but for many years to come sociological inferences can only be drawn from estimates and classifications of this character; and the association of attributes deduced from them, if not as convincing as in the case of measurable characters, is a far better director of social reform than any purely ethical discussion, or philanthropic appeal. In the present case relatively few schools have been examined, but the children have had their environment exhaustively discussed, and their ailments have been medically investigated on a uniform plan. We shall draw largely upon this memoir in our present enquiry, and

after experience of several school surveys (not here discussed) have little hesitation in placing this Edinburgh Report easily first for completeness and reliability.

(3) *On the Inheritance of Visual Characters.* The general impression among ophthalmologists appears to be that the characteristics of vision are inherited, but what the intensity of inheritance, and whether it is the same as that for other physical characters does not yet appear to have been settled. Writing as late as 1907 Messrs Swanzy and Werner* state with regard to myopia that: "Heredity also plays a certain part, which, however, is not quite clear; but it would seem some anatomical or constitutional predisposition must be transmitted to the offspring."

Mr J. Herbert Parsons† cites from a variety of observers the percentages of myopia "in one or both parents" of myopes, and observes that: "Analysis of these statistics leads to the conclusion that only 10 °/₀ show hereditary influence, which is too small a number to be decisive considering the numerous factors which are not taken into account" (p. 1409).

We may remark here as we have had occasion to do elsewhere that apart from these disturbing factors, no such percentage statistics can possibly settle the problem of the intensity of inheritance. The distribution of parents of the normal and the proportion of myopes to normal in the general population (or at any rate in the "universe under discussion") must be found before any appreciation of the effect of heredity can be made. The actual percentages of abnormal in the parents of the abnormal may vary from one abnormality to a second and yet the force of heredity really be the same.

Parsons has further pointed out‡ that myopia is not due to a single cause, and that even the commonest of the forms of myopia, axial myopia, has varieties, and that we hardly yet know whether these clinical varieties differ from each other fundamentally or only in degree. It is possible that some of these varieties are hereditary and others due to environmental conditions. But even here the reader must be reminded that the modern student of heredity will hardly press for the inheritance directly of a diseased condition. We do not consider the inheritance of phthisis or insanity, but of the constitution or diathesis, which leads to these abnormal conditions in the course of growth or in the appropriate environment. This point will be borne in at once on the student of deaf-mutism; he will find so-called congenital and non-congenital cases, the latter frequently following on special environmental conditions occurring in early life. But the non-congenital cases occur largely in special stocks and not infrequently in stocks where congenital cases also occur. Thus the inheritance is one of a constitutional weakness, the defect becoming actual with growth or a suitable environment; or possibly in uterine existence. Ultimately no doubt distinction will be made between various types of myopia, but it is not unreasonable in the present state of our knowledge to test the intensity of inheritance

* *A Handbook of the Diseases of the Eye and their Treatment*, 1907.

† *Pathology of the Eye*, Vol. IV. 1908, pp. 1409, 1410.

‡ *loc. cit* Vol. I. 1904, p. 968 et seq.

on the basis of broad classifications. Further, if non-hereditary varieties exist and have been included in our classification it follows that we shall not be over- but underestimating the numerical value of the hereditary factor*.

Groenouw and Abelsdorf are cited by Steiger† to show that at the time of his memoir (1906) inheritance in the cases of myopia and astigmatism was still an unsettled problem. Steiger himself has advanced the question immensely and our first object will be to render his results comparable with our knowledge of heredity in other physical characters.

Steiger deals with the two problems of refraction and astigmatism, and he considers the distributions among parents and offspring, and among the members of a sibship (or fraternity). The comparatively steady value of astigmatism in the individual precludes the suggestion of a post-uterine origin of the character, and the fact that the father is as influential as the mother leads us, using Occam's razor, to accept heredity rather than an intra-uterine source for astigmatism. That Steiger definitely demonstrates the inheritance of both refraction and astigmatism should, we think, be fully accepted. The real problem before us is to determine what the intensity of inheritance may be according to Steiger's data and the difficulty of solution lies in the fact that these data do not provide a random sample of the general population.

The first mootpoint that occurs in dealing with the inheritance of refraction, concerns the determination of the unit, which we shall use to obtain a quantitative scale. The refractive power of the corrective lens is inversely as its focal distance, and this refractive power is now universally adopted in the measurement of refraction, the unit being a lens of one metre focal distance, of which the refractive power is termed a diopter. Under an older system the actual focal length of the lens needed for correction was stated. In other words expressed mathematically the character to be measured in the former case is expressed by C/x and the latter case by x, where C is a mere constant due to change of scale. Now if x_1 and x_2 be the values of the character in two individuals, it is not the same thing to correlate x_1 and x_2 as to correlate C/x_1 and C/x_2; the resulting intensity of association will only be the same if the deviations of x_1 and x_2 from the mean values in the population are small compared with that mean value. Now an examination of

* Further references to the heredity of visual characters will be found in: H. Cohn, *The Hygiene of the Eye in Schools*, Chap. x. 1883. Cohn gives percentages of myopic parents of myopic children, but considers the question of the heredity of myopia not yet decided.

Opinions on the heredity of myopia without mass statistics are given by:

Priestley Smith: "Diagnosis, Prognosis and Treatment of Pernicious Myopia," *Brit. Med. Journal*, Oct. 19, 1901, p. 1162. ("Tendency to myopia frequently inherited.")

C. A. Oliver: Norris and Oliver: *System of Diseases of the Eye*, London, 1897, Vol. IV. p. 425.

S. D. Risley: *Ibid.* Vol. II. p. 362. ("Therefore if heredity has any important place in the history of the near-sighted eye, it lies in production of these anatomical defects. I am of opinion congenital anomalies in the form of the eyeball are hereditary rather than myopia or any tendency to myopia." Dr Risley attributes the myopic tendency to certain distortions in the form of the skull, which affect the shape of the orbits.)

Fuchs: *Textbook of Ophthalmology*, trans. by A. Duane, 3rd ed. 1908, p. 758. (Inheritance of correlated anatomical conditions giving rise to myopia.)

† (B) Bd. XVI. p. 229.

our table on p. 22 shows that the variation in corneal refraction is about 3 °/$_o$ of the mean value. For statistical purposes therefore it would not matter very much whether we considered the character to be measured by C/x or by x. On the other hand for corneal astigmatism the variation is 75 °/$_o$ of the mean value, and whether we use C/x or x may make a sensible difference*. We have examined at some length whether the refractive power of the lens or its focal length ought to be considered as the more fitting *organic* measure of the character. In practice for both refraction and astigmatism the inverse of a certain length is taken now as the measure of the character. This measure has been adopted for its convenience, not because of its physiological significance. We cannot, however, assert that the focal length itself is the better standard, merely because in current anthropometry we are accustomed to measuring actual lengths in the human organism, and determining the degree of inheritance of these lengths. The lengths determined by the correcting lenses are not simple measurable lengths of the eye itself, but complex functions of the lengths of the parts of the eye (radii of curvature, thickness of the lenses, distances of lenses apart and from the retina, etc.). Nor is it possible to deduce from the focal length of the corrective lens, any simple dimension of the given eye. Yet as a matter of fact values obtained for the inheritance coefficients in the case of refraction appear to be somewhat more consonant with the values obtained for the inheritance of other measurable characters in man, if we use direct focal lengths instead of the refractive powers of the correcting lenses. For example: the resemblance in corneal refraction of brothers and sisters falls from ·63 to ·40 if we use focal lengths instead of diopters as the measure of the character. It seems, however, better to avoid questions of "fitter" organic scale—as "fitness" itself is a matter of definition—by using whenever it is possible the method of contingency, fundamentally, or for purposes of control. In this case, whether we classify by diopters or focal lengths, our results are precisely the same.

In taking either diopters or focal lengths as the measure of the defect, we are fully aware that we are not dealing with an anthropometrically simple character of the eye. But if a quantity z be a function of any number of simple quantities $x_1, x_2 \dots x_n$ which are inherited at the same rate and have variabilities small relative to their mean values, then it has been shown† that z will be inherited at precisely the same rate as these other simple characters, provided the coefficient of cross-heredity is equal to the product of the coefficient of direct heredity into the organic correlation of any two organs. The latter condition does not appear to be absolutely satisfied in the case of physical measurements on man‡, but it is certainly approximately true, and the degree of approximation is close enough to enable us to test heredity on complex characters as well as on simple lengths.

(4) *On a measure of the Selection used when we deal with the cases of Corneal*

* A similar problem arises when we use "magnitude" instead of "amount of light" in stellar statistics.

† Pearson, *R. S. Proc.* Vol. 62, p. 411; *Phil. Trans.* Vol. 187, A, p. 259.

‡ Pearson and Lee, *Biometrika*, Vol. II. pp. 383, 393.

Astigmatism collected by the Ophthalmologist in place of a Random Sample of the General Population.

Steiger (B) Bd. XVI. S. 236 gives a table of the distribution of 3170 Berne school children not selected for visual defect. This includes:

(α) 882 ♂ eyes, from a boys' secondary school, ages 11—16
(β) 620 ♂ " " " primary " " 9—15
(γ) 1034 ♀ " " girls' secondary " " 12—16
(δ) 634 ♀ " " " primary " " 9—15

The characteristic investigated was corneal astigmatism.

TABLE I. *Corneal Astigmatism in General Child Population.*

Diop.	−0·5	−0·25	0	0·25	0·5	0·75	1	1·25	1·75	2·625	3·5	Totals
(α)	—	7	51	100	275	238	97	65	26	15	8	882
(β)	4	8	39	94	153	175	67	38	29	9	4	620
(γ)	—	14	43	79	264	310	108	85	90	22	19	1034
(δ)	1	4	32	60	125	206	82	60	44	10	10	634

We have selected after some consideration 3·5 D to centre the last group which Steiger classes as "more than 3·0 D." His previous group is 2·25—3·0 inclusive, and his observing unit appears to be ¼ D. There results from this Table:

	Mean	Standard Deviation	Coefficient of Variation
(α) Boys, 11—16 years	·715 ± ·012	·520 ± ·008	72·7
(β) Boys, 9—15 years	·695 ± ·014	·529 ± ·010	76·2
(γ) Girls, 12—16 years	·848 ± ·013	·605 ± ·009	71·3
(δ) Girls, 9—15 years	·829 ± ·016	·585 ± ·011	70·6

We can conclude at once from these results that:

(i) The girls are more astigmatic than the boys and more variable, if we judge as, I think, is needful in this case (owing to the possibility of negative values) by the standard deviation and not the coefficient of variation.

(ii) In both cases there is possibly a slight reduction of astigmatism with age, but it is hardly sensible and not determinable on the data provided. Change in variability with age is doubtful, and different for the two sexes.

We may conclude that for the general child population we may take for corneal astigmatism:

	Mean	Standard Deviation	Coefficient of Variation
Boys	·705	·525	74·5
Girls	·839	·595	70·9

The question that next arises is: What change in these constants is made when such material passes through the hands of the ophthalmologist, who selects and deals only with that portion of his material which he considers abnormal?

An apparent answer is given by Steiger ((B) XVI. S. 237). 32,654 Zürich

school children were examined, and the boys (16,233) showed in 8·5 °/ₒ of cases, the girls (16,421) in 10·6 °/ₒ of cases an astigmatism which alone or to a great part affected their keenness of vision. Now if the selection were simply made on the basis of excessive astigmatism "according to the rule" we should find the mean increased but the standard deviation decreased after the ophthalmologist had made his selection. But this is very far from the fact. In all cases of material selected as possessing defective vision the mean of the corneal astigmatism is raised, but at the same time the standard deviation is very largely raised also. This follows because the classes of astigmatism "against the rule," *i.e.* the persons with the greater curvature in the horizontal meridian, noted in the above table with a minus sign, are also largely selected. Excess of astigmatism "according to the rule" is more frequent than excess "against the rule"; the curve of distribution in the general child is not very widely different from normality, but the tail "according to the rule" is sensibly exaggerated beyond the tail "against the rule," *i.e.* there is skewness in the sense of the positive astigmatism. The selection curve is actually U-shaped and the resulting standard deviation much increased. Unfortunately we have not the numbers but only Steiger's diagram of the percentages of each class in the selected children ((B) XVI. p. 237), but it is sufficient to indicate that if these could be reduced to percentages of each class in the normal Berne population we should find a skew U-curve for our selection curve. The following is our rough attempt to reach this from Steiger's diagram taking Boys ((*a*) above) as the normal population.

Ophthalmological selection from general boy population of 8·5 °/ₒ of astigmatics:

	'Against the Rule'	0	0·25	0·5	0·75	1	1·25	1·75	2·625	Over 3
Distribution of 8·5°/ₒ	·17	·24	·33	·57	·46	·46	·66	2·27	1·76	1·58
Percentage of each class of normal population taken	21·2	4·1	2·9	1·8	1·7	4·2	8·9	78·3	103·5	175·6

This brings out the skew U-shaped nature of the selection curve. The two last percentages exceeding 100 °/ₒ show that all the individuals at Zürich with 2·0 D or more were actually selected and that in the Berne population there were fewer of these cases than existed in Zürich. The mean of the selected Zürich boy population is 1·89 D and the standard deviation 1·08 D*; thus indicating that the mean has been more than doubled, and the standard deviation not quite doubled.

Of course this rough result cannot be directly applied from children to adults, but it may suffice to indicate the direction of ophthalmological selection. It is not a simple selection which cuts off one tail only of the distribution. Another point is also to be noticed. In actual practice the selection will most generally be of adults, and the corneal astigmatism of these will be different from that of children. Steiger's results ((A) p. 22) are very regular and show sensible decrease of

* Based on the values of the 8·5 °/ₒ distribution given above.

corneal astigmatism from the year 10, onward to the end of life. His published data do not permit of our ascertaining the exact correlation between age and astigmatism*; it is probably less than that between refraction and age and will not therefore be further considered here†.

(5) *On Parental Inheritance. Corneal Astigmatism.* Unfortunately Steiger does not give very detailed tables for this. A correlation table is given for mothers and sons only and this for comparatively few cases and for rather large groupings. For the three other parental cases we have only fourfold tables.

On S. 347 (B) XVI. we have the following table:

TABLE II. *Corneal Astigmatism, Mothers and Sons.*

Mothers

Sons	Against the rule and 0—1·0	1·25—2·0	2·25—3·0	3·25—4·0	4·25—5·0	5·25—6·0	Totals
Against the rule and 0—1·0	29	8	3	—	—	—	40
1·25—2·0	26	16	6	1	3	—	52
2·25—3·0	13	4	3	4	—	—	24
3·25—4·0	10	7	4	6	—	1	28
4·25—5·0	4	4	2	2	2	1	15
5·25—6·0	1	2	—	—	2	—	5
Totals	83	41	18	13	7	2	164

Dealt with by the product-moment method we find:

Sons: Mean 2·1402, S.D. 1·4051;
Mothers: Mean 1·4390, S.D. 1·2282.
Correlation = ·3760 ± ·0452.

Throwing the small groups 4·25—5·0 and 5·25—6·0 together and using mean square contingency we find: $C_2 = \cdot 3848$. This is sufficiently close to the value of

* We have sought in vain for reducible statistics on this point.

† Steiger himself says that astigmatism according to the rule is congenital. It has never been found to occur after birth, and no statistics demonstrate a more intense astigmatism according to the rule in later years. A reduction, sometimes very sensible, may occur in its value. (B) XVI. S. 231.

the correlation coefficient to make us conclude that ·38 is a fair value of the relationship.

The material is obviously highly selected. In the general boy population (α) we have 87 % of astigmatism of 1·0 D or less, and 79 % in the general girl population (γ). In our present table the boys with less than 1·0 or 1·0 D are 24 % and their mothers 51 % of the total. This suggests that the selection has been by the children rather than by the mothers*. It would follow from this that we ought to obtain from the data the true regression line of mothers on sons. Let r_{ms}, σ_m, σ_s be the unselected values of the correlation and standard deviations of mothers and sons; $\bar{r}_{ms}$, $\bar{\sigma}_m$, $\bar{\sigma}_s$ the selected values, then

$$r_{ms}\,\sigma_m/\sigma_s = \bar{r}_{ms}\,\bar{\sigma}_m/\bar{\sigma}_s = \cdot 3760\,\frac{1\cdot 2282}{1\cdot 4051} = \cdot 3287.$$

Hence, if the character were equally variable in ♂ and ♀, the correlation r_{ms} would be $\frac{1}{3}$. If, however, we give the variabilities the ratio determined on p. 7, this is reduced to ·29.

It must be admitted that this value, while quite significant and demonstrating the inheritance of corneal astigmatism, is considerably less than what has been found for other physical characters in man. The data however are sparse and we cannot be certain of the exact nature of the selection which has taken place, *i.e.* there are probably cases in which the mother is the selected and the son only the indirectly selected individual. Such a process it is easy to show would substantially lower the correlation. For if the mothers had been the directly selected individuals the slope of the regression line of sons on mothers would be unchanged by selection or:

$$r_{ms}\,\sigma_s/\sigma_m = \bar{r}_{ms}\,\bar{\sigma}_s/\bar{\sigma}_m = \cdot 4301,$$

whence

$$r_{ms} = \cdot 4301 \times \sigma_m/\sigma_s = \cdot 49.$$

Thus the true value of the correlation can range from ·29 to ·49 according to the amount and nature of the selection. As we have seen, however, there appears to be a greater selection of children than of mothers, and the true value probably approaches somewhat nearer the lower limit.

We may see as far as our means extend how far the other parental relations confirm or modify the result just reached. Steiger gives the following four four-fold tables of which the second is the material already discussed ((B) XVI. p. 348).

* Steiger writes ((B) XVI. p. 234): "Unser Material stammt zum Teil aus der Sprechstunde, zum weitaus grössten Teil aber aus den städtischen Schulen von Zürich, und besteht in erster Linie aus den Schulkindern selbst, dann aber auch aus begleitenden Eltern oder Geschwistern." In all material of this sort it is for statistical purposes essential that the "directly selected" and the not directly selected individuals should be distinguished in the data.

TABLE III. *Inheritance of Corneal Astigmatism.*

		(i) Fathers			(ii) Mothers		
		Up to 2·0 D	More than 2·0 D	Totals	Up to 2·0 D	More than 2·0 D	Totals
Sons	Up to 2·0 D	83	17	100	79	13	92
	More than 2·0 D	45	17	62	45	27	72
	Totals	128	34	162	124	40	164

		(iii) Fathers			(iv) Mothers		
		Up to 2·0 D	More than 2·0 D	Totals	Up to 2·0 D	More than 2·0 D	Totals
Daughters	Up to 2·0 D	95	19	114	126	23	149
	More than 2·0 D	51	19	70	55	40	95
	Totals	146	38	184	181	63	244

These give for uncorrected correlation coefficients:

$$\bar{r}_{fs} = \cdot 218, \qquad \bar{r}_{ms} = \cdot 446^*,$$
$$\bar{r}_{fd} = \cdot 220, \qquad \bar{r}_{md} = \cdot 478.$$

The correction, supposing we take as before the offspring as selected, becomes more hypothetical in this case because we have no values for $\bar{\sigma}_d$ or $\bar{\sigma}_f$. It is clear that the $\bar{\sigma}_f$ whether found from the son or daughter table will be much the same; this also applies to $\bar{\sigma}_m$. Further $\bar{\sigma}_d$ as found from the father table will be probably much the same as that found from the mother table: this is suggested by the ratio of the frequency in the two classes remaining much the same in the two tables in which each individual appears. But this is not the case for the sons in the tables of fathers and mothers. Still we have no possibility of finding $\bar{\sigma}_s$ from the father table and can only assume it equal to the value found from the mother table in its extended form†. The best we can do to find a value for $\bar{\sigma}_d$ is to take the known $\bar{\sigma}_s$ and increase it in the ratio of sex variabilities, and to find a value for $\bar{\sigma}_f$ to take the known $\bar{\sigma}_m$ and reduce it in the ratio of the sex variabilities. Thus we have:

$$\bar{\sigma}_f = 1\cdot 0837, \qquad \bar{\sigma}_m = 1\cdot 2282,$$
$$\bar{\sigma}_s = 1\cdot 4051, \qquad \bar{\sigma}_d = 1\cdot 5924.$$

* This is considerably in excess of the value found by the product-moment method, *i.e.* ·378.

† Table III (i) suggests from its row totals that the son in the father-son series was less frequently the selected member than in the case of the mother-son series.

For fathers and sons, assuming as before that $\sigma_f = \sigma_s$, of which we have no satisfactory evidence:

$$r_{fs} = r_{fs}\frac{\sigma_f}{\sigma_s} = \bar{r}_{fs}\frac{\bar{\sigma}_f}{\bar{\sigma}_s} = \cdot 168,$$

$$r_{ms} = \frac{\sigma_s}{\sigma_m} r_{ms}\frac{\sigma_m}{\sigma_s} = \frac{\sigma_s}{\sigma_m}\left(\bar{r}_{ms}\frac{\bar{\sigma}_m}{\bar{\sigma}_s}\right) = \cdot 344,$$

$$r_{fd} = \frac{\sigma_d}{\sigma_f} r_{fd}\frac{\sigma_f}{\sigma_d} = \frac{\sigma_d}{\sigma_f}\left(\bar{r}_{fd}\frac{\bar{\sigma}_f}{\bar{\sigma}_d}\right) = \cdot 170,$$

$$r_{md} = r_{md}\frac{\sigma_m}{\sigma_d} = \bar{r}_{md}\frac{\bar{\sigma}_m}{\bar{\sigma}_d} = \cdot 369.$$

The results for father with son and for father with daughter are consistent with each other, and the two results for mother with son and with daughter are fairly close and not so widely divergent from that previously found by a different method. But one can hardly accept as final these low values nor believe that this is an exceptional case, where the influence of mother is twice as great as that of the father. It seems more reasonable to suppose that the selection has not been made wholly by children, and that the direct selection of parents has been greater in the case of fathers than in that of mothers.

(6) *On Fraternal Inheritance. Corneal Astigmatism.* The most satisfactory table given by Steiger for our present purposes is the following* ((B) XVI. p. 238):

TABLE IV. *Resemblance of Sisters.*

Astigmatic's Sister

Astigmatic ♀	Against the rule	0·25—1	1·25—2	2·25—3	3·25—4	4·25—5	5·25 and over	Totals
Against the rule	1	—	—	—	—	—	—	1
0·25—1	4	33	1	—	—	—	—	38
1·25—2	4	47	37	5	2	—	—	95
2·25—3	1	23	44	19	3	—	—	90
3·25—4	—	15	30	32	8	—	—	85
4·25—5	—	3	10	10	7	2	—	32
5·25 and over	—	—	9	1	1	1	—	12
Totals	10	121	131	67	21	3	—	353

* In reducing this table Sheppard's corrections were used; they seemed hardly legitimate in Table II, owing to want of high contact. If used the correlation is ·3952 instead of ·3760 as entered.

Mean of astigmatics = 2·656, S.D. = 1·2451,

Mean of their sisters = 1·560, S.D. = ·9342.

Correlation = ·5838.

$$r_{ss} = r_{as}\frac{\sigma_s}{\sigma_s} = \bar{r}_{as}\frac{\bar{\sigma}_s}{\bar{\sigma}_a} = {\cdot}438.$$

Thus we find a substantial relation between sisters in the unselected population, but somewhat below the value ·5 we are accustomed to find for physical characters in man.

For a fivefold × fivefold table the use of mean square contingency gave $C = {\cdot}556$, which is in quite good agreement with the value given for r. To test the influence of neglecting the fact that the material is an ophthalmological selection of one member of the pair, we destroyed the difference between the two sisters by making the table symmetrical. We found $r = {\cdot}2504$ or the correlation has fallen more than 50 °/ₒ. This effectively illustrates how great the influence in destroying the traces of heredity must be if there be a partial selection of unknown amount from *both* the correlated groups.

For pairs of brothers Steiger unfortunately only gives a 3 × 3 fold table, namely ((B) XVI. p. 240):

TABLE V. *Resemblance of Brothers.*

Astigmatic's Brother

Astigmatic ♂	1·0 and below	1·25—4·0	Over 4·0	Totals
1·0 and below	33	—	—	33
1·25—4·0	54	105	—	159
Over 4·0	6	18	2	26
Totals	93	123	2	218

This does not lend itself to a satisfactory fourfold division. It shows, perhaps, higher correlation than in the case of sister and sister, but the value by a fourfold table will depend largely on where the division is made*.

For brother and sister Steiger ((B) XVI. p. 335) gives a table, which would have been useful had he indicated the selected individuals.

* The mean value does not differ much from that of sister pairs, but the range is roughly from about ·84 to ·30!

TABLE VI. *Resemblance of Brother and Sister.*

Brother \ Sister	0	0·25—1·0	1·25—2·0	2·25—3·0	3·25—4·0	4·25—5·0	5·25—6·0	Totals
0	6	14	9	1	2	—	—	32
0·25—1·0	1	43	47	27	5	5	2	130
1·25—2·0	—	28	67	43	36	6	—	180
2·25—3·0	1	11	36	23	25	8	2	106
3·25—4·0	—	5	26	16	25	7	4	83
4·25—5·0	—	4	2	6	4	3	—	19
5·25—6·0	—	—	1	—	—	2	—	3
Totals	8	105	188	116	97	31	8	553

We find:

Mean of brothers: 1·891, S.D. = 1·2250,
Mean of sisters: 2·193, S.D. = 1·2204.
Correlation = ·3303.

Comparing this with the Berne results we see that there has been very considerable selection. But there is no means of correcting for this, because we have no measure of how many or which individuals have been directly selected. We have seen that in the case of the sisters (p. 13), the effect of confusing the directly and indirectly selected material reduced the uncorrected correlation from ·58 to ·25, or to less than half. Hence it is not unreasonable to suppose that the uncorrected correlation is over ·6, or at least as great as between sister and sister.

(7) *General Conclusions as to the Inheritance of Corneal Astigmatism.* There is certainly inheritance of corneal astigmatism, as evidenced by minimum limits of ·3 to the parental and of ·4 to the fraternal coefficients. But the present material is neither sufficient nor sufficiently classified to enable us to determine with any degree of certainty the accurate value of the inheritance coefficients.

It is ophthalmologically selected, and although it would be possible to allow for this, if we had the raw data, and were told in each case which member of the pair was the "selected" individual, this information is not really given in any of Steiger's tables* and can only be roughly assumed in the case of a few of them.

* We are not certain that the "astigmatic" is in all cases the selected individual, although it is generally the individual with the excess of astigmatism.

Steiger has enormously advanced the conception of what the ophthalmologist can do for heredity by taking the ophthalmic characters of the relatives of his patients. But for statistical reduction it is needful in every case to separate "patient," the "selected" individual, from the relative the "indirectly selected" individual. Tables correlating the characters of these two will not in themselves suffice to demonstrate the intensity of heredity, as Steiger occasionally seems to assert, but they will serve to determine when properly corrected for the "selection" the values of the inheritance coefficients.

The present discussion will at any rate suffice to indicate two conclusions:

(i) That there is a splendid field for a man who will measure the corneal astigmatism in a non-selected population.

(ii) That failing this the ophthalmologist can provide useful results, if he will carefully distinguish between "patient" and relative.

(8) *On the Inheritance of Corneal Refraction.* Steiger has treated his data on this point with more detail than his material for astigmatism. He has indicated that there is not only a sexual difference, but a change with age.

From his data we reach the following results *.

TABLE VII. *Age, Sex and Corneal Refraction.*

	Males			Females		
Group of Ages	To 8 years	10—16	16—88	To 8 years	10—16	16—88
No. of Eyes	248	882	232	252	1034	363
Mean.........	42·88	42·71	42·42	43·59	43·14	42·99
S.D.	1·324	1·287	1·289	1·451	1·204	1·360
	General Mean = 42·75 General S.D. = 1·291 Correlation of Refraction and Age $r = \cdot 174$			General Mean = 43·17 General S.D. = 1·293 Correlation of Refraction and Age = ·155		

* The following is the Table of Frequencies, reconstructed from Steiger's percentages:

	Males			Females		
	To 8 years	10—16	16—88	To 8 years	10—16	16—88
Up to 40	8	21	10	4	8	5
40·25—41	14	60	30	13	45	23
41·25—42	41	180	53	24	155	72
42·25—43	78	279	76	46	294	110
43·25—44	66	194	35	68	321	69
44·25—45	33	120	24	53	154	57
Over 45	8	28	4	44	57	27
Totals	248	882	232	252	1034	363†

† Steiger gives on his diagram (A, p. 46) 368, but we think this must be a misprint.

Now these results show that there is less than ½ diopter difference between the sexes, and that as a whole they are almost equally variable. The females show rather more change in their variability with age, extreme childhood and age are the more variable periods. While the decreasing value of the refraction with age is well marked and the correlation, about ·16, quite sensible, it is not of a value to involve serious corrections in the inheritance correlations. For the correction will depend upon $(\cdot 16)^2$, or introduce only modifications of order ·02 to ·03 into the coefficient, and these are in this case of the order of the probable errors of the results.

Steiger gives us throughout no information as to which individual is the "selected" member of a pair. We shall now proceed to discuss his data.

(9) *Parental Inheritance. Corneal Refraction.* Steiger has given four tables of parental heredity. They are reproduced as VIII, IX, X and XI below. We find the statistical constants tabled in XII on p. 18.

Tables of Parental Heredity, Corneal Refraction. Steiger.

TABLE VIII. *Father and Son.*

Son \ Father	39·25—40	40·25—41	41·25—41·5	41·75—42	42·25—43	43·25—44·25	44·5—45	45·25—46	46·25 and over	Totals
39·25—40	—	3	1	2	—	—	—	—	—	6
40·25—41	—	3	—	1	1	—	—	—	—	5
41·25—41·75	1	3	4	4	1	2	—	—	—	15
42·0—43	—	2	7	8	11	11	4	3	—	46
43·25—44·25	—	2	2	4	6	9	1	4	—	28
44·25—45	—	—	—	1	2	4	6	2	2	17
45·25—46	—	—	—	—	—	3	2	2	—	7
46·25 and over	—	—	—	—	—	—	—	—	—	—
Totals	1	13	14	20	21	29	13	11	2	124

TABLE IX. *Mother and Son.*

Mother

Son	Up to 40	40·25—41	41·25—41·75	42—43	43·25—44·25	44·5—45	45·25—46	46·25—47	47·25 and over	Totals
Up to 40	2	—	—	2	2	—	—	—	—	6
40·25—41	1	1	1	3	2	—	—	—	—	8
41·25—41·75	1	1	—	1	1	1	—	—	—	5
42—43	1	5	—	16	8	2	—	2	—	34
43·25—44	1	—	2	10	9	4	—	—	—	26
44·25—45	—	—	2	—	4	3	1	—	2	12
45·25—46	—	—	—	—	—	—	1	—	—	1
46·25—47	—	—	—	—	1	1	—	—	—	2
47·25 and over	—	—	—	—	—	—	3	1	—	4
Totals	6	7	5	32	27	11	5	3	2	98

TABLE X. *Father and Daughter.*

Father

Daughter	39·25—40	40·25—41	41·25—41·5	41·75—42	42·25—43	43·25—44·25	44·5—45	45·25—46	46·25 and over	Totals
Up to 41	—	2	—	1	—	—	—	—	—	3
41·25—42	2	4	—	3	2	—	—	—	—	11
42·25—42·5	—	4	—	2	2	—	—	—	—	8
42·75—43	—	—	—	2	5	2	—	—	—	9
43·25—44	—	—	3	—	7	5	1	—	2	18
44·25—45·5	—	3	—	—	5	9	4	—	4	25
45·75—47	—	—	—	—	4	4	2	—	—	10
47·25—48	—	—	—	—	—	—	2	—	2	4
48·25 and over	—	—	—	—	—	2	—	—	—	2
Totals	2	13	3	8	25	22	9	0	8	90

TABLE XI. *Mother and Daughter.*

Mother

Daughter	Up to 40	40·25—41	41·25—42	42·25—43	43·25—44	44·25—44·5	44·75—45	45·25—46	46·25 and over	Totals
Up to 40	—	—	—	—	—	—	—	—	—	0
40·25—41	1	3	1	1	1	—	—	—	—	7
41·25—42·25	—	5	5	5	4	1	—	—	—	20
42·5—43	1	—	4	—	8	—	—	—	—	13
43·25—44	—	—	2	1	21	5	3	1	1	34
44·25—45·25	—	2	—	1	8	7	2	3	3	26
45·5—46	—	—	—	2	3	5	—	2	3	15
46·25—47	—	—	—	—	—	3	1	—	7	11
47·25 and over	—	—	—	—	—	—	—	1	1	2
Totals	2	10	12	10	45	21	6	7	15	128

TABLE XII. *Coefficients of Inheritance, Corneal Refraction.*

Class	No.	Means	Standard Deviations	Correlation: Product Moment	Correlation: Contingency
Fathers of Sons	124	42·95	1·565	·610	·601 (5 × 6)
Sons of Fathers	124	42·90	1·406		
Mothers of Sons	98	43·13	1·699	·510	·585 (5 × 5)
Sons of Mothers	98	42·99	1·710		
Fathers of Daughters ...	90	42·99	1·684	·584	·623 (5 × 6)
Daughters of Fathers ...	90	43·78	1·842		
Mothers of Daughters ...	128	43·71	1·660	·718	·646 (5 × 5)
Daughters of Mothers ...	128	43·88	1·668		
			Mean.........	·605	·614

Now it must be at once admitted that two factors affect the striking heredity exhibited in these results. The first is the remarkable system of sub-ranges selected by Steiger to tabulate his results. No reasonable explanation is given of this system, and it is utterly unsuited to statistical reduction. The group ranges are occasionally 1·25, occasionally ·75, occasionally 1, and again ·5. And these ranges vary from table to table, even when one of the pair is the same. It would appear as if some attempt had been made to smooth the frequencies in this manner, possibly in order to get rid of a tendency to read to ½ instead of ¼ diopters, from which Steiger, notwithstanding his criticism of Chauvel (A, p. 18), does not himself seem wholly free. Whatever the source of this choice of sub-ranges *, it enormously increases the labour of the statistician and renders his correction of the moments of doubtful application †.

Secondly, there are anomalies of which no explanations are forthcoming. We should expect to find roughly mothers of sons and of daughters to be alike, approximately fathers of sons and of daughters give the same constants; but the mothers of daughters have sensibly higher refraction than mothers of sons. Again, we note that sons of mothers are sensibly more variable than sons of fathers, and daughters of fathers sensibly more variable than daughters of mothers. This increased variability when we deal with the offspring of the opposite sex may be the source of the reduced heredity, in this case between the opposite sexes. It is impossible to say whether this result—important if it were true—is in whole or part produced by the changing of sub-range systems to which we have just referred.

We have verified the generally high values of the correlation between parents and offspring by recalculating the coefficients by mean square contingency. Their high values are thus confirmed. The high values of the variabilities for refraction in Table XII compared with those in Table VII, show that we are dealing with *highly selected* material, but the slight changes of means seem to indicate that the selection is largely one of extremes. The parental variability is raised almost as much as that of the offspring and one hesitates to assert that parents have in the bulk been indirectly selected by selection of their offspring, or that offspring have been indirectly selected by direct selection of their parents. There is nothing in the text to assist us to a conclusion.

In the discussion on corneal astigmatism we noticed that at a maximum the correction for selection might reduce the correlation by about 25 °/ₒ. This would reduce our rough value of ·61 to ·46, a value strikingly close to the average value found for other physical characters in man ‡.

We may safely conclude that corneal refraction is inherited at the same rate as other physical characters in man.

Of course the same point impresses itself upon us here as in dealing with astigmatism, the urgent need to measure a large random sample, not an ophthalmological selection, of the general population of parents and offspring. Such a system of measurements combining astigmatism and refraction would offer splendid material also for testing theories of cross heredity.

* We find no justification for it in Steiger's remarks in (B) XVII. p. 445.

† Sheppard's correction has been made for an approximate average sub-range.

‡ Stature ·51, span ·48, forearm ·42, eye colour ·50, each based on 4000 to 5000 measurements.

(10) *Collateral Heredity, Corneal Refraction.* Steiger provided three tables of fraternal resemblance, which we reproduce as Tables XIII, XIV and XV. The following table, Table XVI on p. 22, sums up the values of the deduced statistical constants. As we could find no consistent difference between the pairs tabled by Steiger, nor any evidence as to the "selected" member, we have made Tables XIII and XIV symmetrical. Thus they contain twice the numbers in Table XVI.

Tables of Fraternal Resemblance. Corneal Refraction. Steiger.

TABLE XIII. *Pairs of Brothers.*

1st Brother

2nd Brother	39·25—40	40·25—41	41·25—42	42·25—43	43·25—44	44·25—45	45·25—46	46·25—47	47·25—48	48·25—49	Totals
39·25—40	6	2	1	2	—	—	—	—	—	—	11
40·25—41	2	4	10	4	1	—	—	—	—	—	21
41·25—42	1	10	16	11	7	5	2	2	—	—	54
42·25—43	2	4	11	22	17	14	2	1	—	—	73
43·25—44	—	1	7	17	30	21	5	—	—	—	81
44·25—45	—	—	5	14	21	—	3	3	1	—	47
45·25—46	—	—	2	2	5	3	4	—	1	2	19
46·25—47	—	—	2	1	—	3	—	2	1	—	9
47·25—48	—	—	—	—	—	1	1	1	—	—	3
48·25—49	—	—	—	—	—	—	2	—	—	—	2
Totals	11	21	54	73	81	47	19	9	3	2	320

TABLE XIV. *Pairs of Sisters.*

1st Sister

2nd Sister	40·25—41	41·25—42	42·25—43	43·25—44	44·25—45	45·25—46	46·25—47	47·25—48	Totals
40·25—41	4	4	1	4	—	—	—	—	13
41·25—42	4	8	9	14	3	3	—	—	41
42·25—43	1	9	30	28	15	11	—	—	94
43·25—44	4	14	28	42	34	7	6	2	137
44·25—45	—	3	15	34	38	12	2	2	106
45·25—46	—	3	11	7	12	8	8	4	53
46·25—47	—	—	—	6	2	8	—	—	16
47·25—48	—	—	—	2	2	4	—	—	8
Totals	13	41	94	137	106	53	16	8	468

TABLE XV. *Brother and Sister.*

Brother

Sister	39·25—40	40·25—41	41·25—42	42·25—43	43·25—44	44·25—45	45·25—46	46·25—47	47·25—48	Totals
39·25—40	3	3	3	1	—	—	—	—	—	10
40·25—41	4	5	6	3	3	—	—	—	—	21
41·25—42	3	7	18	9	1	—	2	—	—	40
42·25—43	5	8	15	29	13	2	2	—	—	74
43·25—44	—	—	11	18	29	9	3	—	2	72
44·25—45	—	1	7	26	27	17	9	4	—	91
45·25—46	—	2	1	5	14	11	8	5	—	46
46·25—47	—	—	—	3	—	2	3	—	2	10
47·25—48	—	—	—	2	—	4	1	5	—	12
Totals	15	26	61	96	87	45	28	14	4	376

It is a noteworthy feature of these tables that whereas 10 sisters out of 376 with brothers have a refraction 40 D or under, not a single sister out of 468 with a sister occurs in this group. It is difficult to see how the existence of a brother could lower the sister's refraction, but as we indicate later there is something anomalous about Table XIV.

TABLE XVI. *Corneal Refraction. Fraternal Resemblance.*

Class	No.	Means	Standard Deviations	Correlations	
				Product Moment	Contingency
Pairs of Brothers	160	43·14	1·516	·628	·553 (5 × 5)
Pairs of Sisters	234	43·79	1·397	·407	·423 (5 × 5)
Brother and Sister	376	Brother 43·10 Sister 43·64	1·652 1·717	·632	·577 (5 × 5)
			Mean ...	·556	·518

Again we mark the same sort of anomalies arising as in the parental tables, when we compare members of different sexes, the variabilities being greater with different sexes than with like sexes. The low value of the sister-sister correlation is remarkable, but we see no explanation of the result in the tabled data.

We have here also no possibility of correcting for selection, but the reduction will be less than in the case of the parental tables. The sister pairs are the weak point, but on the whole the constants may be said to be in good agreement with those hitherto found for fraternal resemblance*.

The results taken all round are quite sufficient to indicate that corneal refraction falls well into line with other human characteristics and would amply repay full investigation not only by the scientific value of the results, but by the importance of the subject from the eugenic standpoint.

(11) *Interrelations of Refraction, Keenness of Vision and Age.* The chief objection to Steiger's data lies in the fact that it consists of an ophthalmological selection and that the individuals selected are not defined. There is in the material cited by us in Section (1) data for approaching the problem from the side of collateral heredity without the difficulty of this selective action. That material also provides us with interesting relations between age, keenness of vision and refraction. It seems desirable to consider these interrelations before returning to the problem of heredity.

(a) *Keenness of Vision and Refraction.*

We take first Keenness of Vision and Refraction in its various forms. Table XVII for boys and Table XVIII for girls are based on the material provided in (F)

* Stature ·51, span ·55, forearm ·49, eye colour ·52.

the *Edinburgh Charity Organisation Report.* The children are classed under *Emmetropia, Hypermetropia, Hypermetropic Astigmatism, Mixed Astigmatism, Myopia* and *Myopic Astigmatism.* We have two methods of determining the

TABLE XVII. *Keenness of Vision and Refraction. Boys.*

Refraction	Keenness of Vision						
	6/6	6/9	6/12	6/18	6/24	6/36	Totals
Emmetropia	391	15	5	21	5	1	438
Hypermetropia.....................	53	34	5	9	—	1	102
Hypermetropic Astigmatism ...	21	13	10	18	1	—	63
Mixed Astigmatism...............	3	4	2	5	2	4	20
Myopic Astigmatism	—	2	2	4	2	—	10
Myopia	1	1	1	2	1	3	9
Totals	469	69	25	59	11	9	642

TABLE XVIII. *Keenness of Vision and Refraction. Girls.*

Refraction	Keenness of Vision						
	6/6	6/9	6/12	6/18	6/24	6/36	Totals
Emmetropia	291	13	—	25	7	3	339
Hypermetropia.....................	43	21	15	3	—	—	82
Hypermetropic Astigmatism ...	30	25	12	9	2	—	78
Mixed Astigmatism...............	3	5	4	7	2	1	22
Myopic Astigmatism	—	3	3	1	2	—	9
Myopia	—	1	2	3	—	1	7
Totals	367	68	36	48	13	5	537

relationship between these classes of refraction and keenness of vision as measured in the usual way by Snellen's test type at 6 metres. Namely we may treat the material as a contingency table without using quantitative measures, or we may look upon keenness of vision as a continuous quantity—not very well determined indeed by existing ophthalmological methods—and find the mean value of each refraction class and thence the correlation ratio.

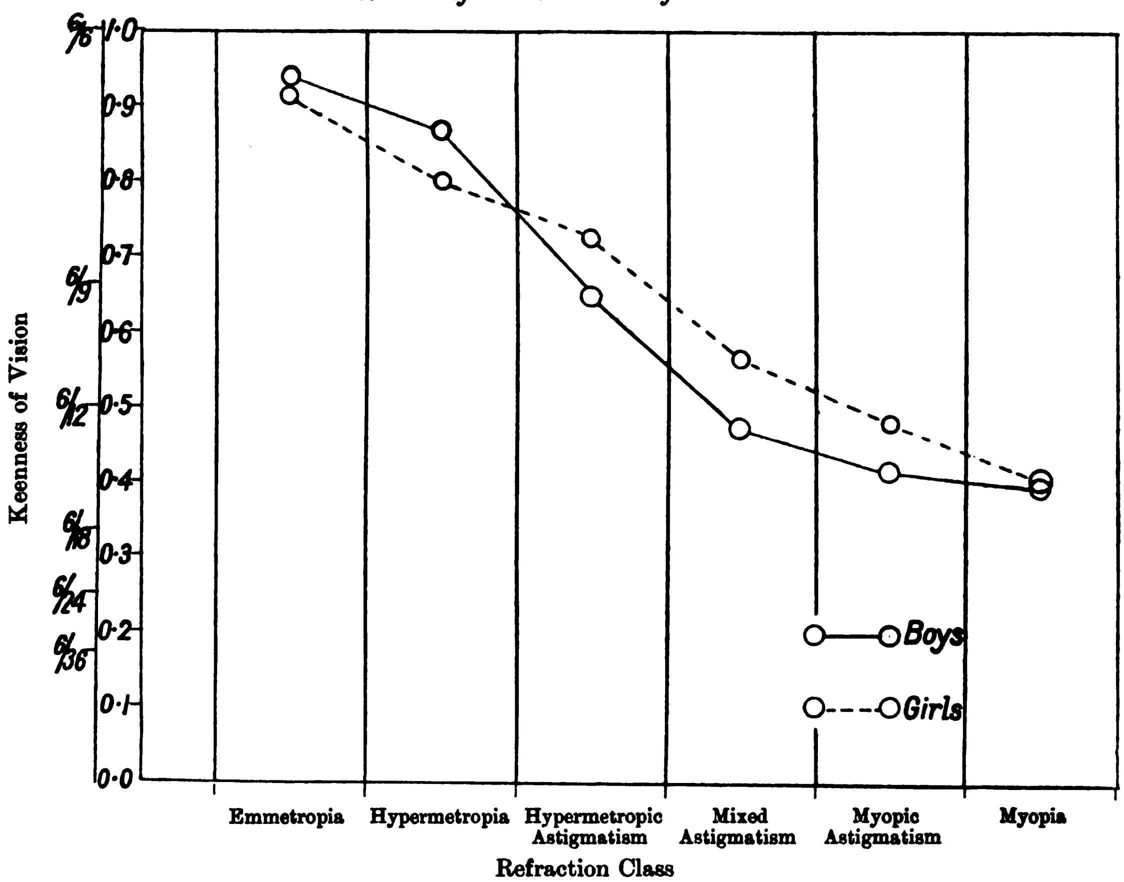
We have the following results.

TABLE XIX. *Refraction and Keenness of Vision.*

<table>
<tr><th rowspan="2"></th><th colspan="2">Keenness of Vision</th><th colspan="2">Correlation of Refraction and Keenness of Vision</th></tr>
<tr><th>Mean</th><th>S.D.</th><th>Contingency (5 × 6)</th><th>Correlation Ratio</th></tr>
<tr><td>Boys ...</td><td>·859</td><td>·249</td><td>·582</td><td>·569</td></tr>
<tr><td>Girls ...</td><td>·839</td><td>·254</td><td>·536</td><td>·431 *</td></tr>
<tr><td rowspan="7">Mean values of Keenness of Vision for each refraction group</td><td colspan="2"></td><td>Boys</td><td>Girls</td></tr>
<tr><td colspan="2">Emmetropia</td><td>·940</td><td>·915</td></tr>
<tr><td colspan="2">Hypermetropia</td><td>·870</td><td>·799</td></tr>
<tr><td colspan="2">Hypermetropic Astigmatism</td><td>·650</td><td>·727</td></tr>
<tr><td colspan="2">Mixed Astigmatism</td><td>·475</td><td>·563</td></tr>
<tr><td colspan="2">Myopic Astigmatism</td><td>·417</td><td>·482</td></tr>
<tr><td colspan="2">Myopia</td><td>·398</td><td>·405</td></tr>
</table>

DIAGRAM I.

Keenness of Vision and Refraction Class.



* Reworked, but we failed to discover any error in this curiously low value.

We may conclude from these results that the vision of the girls is possibly slightly less keen than that of the boys; both are equally variable. The two methods, while leading to somewhat different results for the girls, show that there is a close relationship between refraction and keenness of vision; in girls it may be slightly less than boys, but till further data are forthcoming we may take the degree of contingency as ·56 for both sexes. The accompanying Diagram I expresses graphically the relationship; of course no attempt at anything of the nature of a horizontal scale is supposed to exist in this diagram.

The results show at once how much more influence myopia has on keenness of vision than hypermetropia, and they indicate that refraction defects contribute more than half the abnormality of keenness of vision.

(b) *Age and Refraction.*

We have already found (p. 15) a relation between corneal refraction and age. We have now to consider the relationship between the various types of refraction and age. It is well known that young children are hypermetropic and tend with age to become emmetropic or occasionally myopic. We have three sets of data we can use here: (i) Tables formed from the Edinburgh data with the six classes of Tables XVII and XVIII. In Tables XX and XXI the data are given for boys and girls respectively. This material is from rather poor class schools, but there is no selection whatever. (ii) Rowan's material cited as (D) on p. 3. There appears to have been no selection of the children, but the results show more defective sight than the Edinburgh returns. (iii) Thompson's material cited as (C) on p. 2. This is "selected" material; no returns are unfortunately made of the number of normal children of each agé in the schools examined, and we have again all the difficulties connected with Steiger's data. Rowan's material is given in Tables XXII and XXIII, and Thompson's in Tables XXIV and XXV. Unfortunately Rowan only gives three age groups.

TABLE XX. *Refraction Class and Age. Edinburgh Boys.*

Refraction Class	Age					
	4—7	7—9	9—11	11—13	13—15	Totals
"Normal"	54	112	134	114	41	455
Hypermetropia	19	24	27	26	7	103
Hypermetropic Astigmatism	12	19	10	13	10	64
Mixed Astigmatism	4	6	4	4	1	19
Myopia and Myopic Astigmatism	0	5	5	4	4	18
Totals	89	166	180	161	63	659

TABLE XXI. *Refraction Class and Age. Edinburgh Girls.*

Refraction Class	Age					
	5—7	7—9	9—11	11—13	13—15	Totals
"Normal"	56	83	107	76	29	351
Hypermetropia	15	23	28	12	6	84
Hypermetropic Astigmatism	24	21	10	15	6	76
Mixed Astigmatism	10	4	4	3	1	22
Myopia and Myopic Astigmatism	0	4	2	11	3	20
Totals	105	135	151	117	45	553

TABLE XX *bis* *. *Refraction Class and Age. Edinburgh Boys.*

Refraction Class	Age					
	5—7	7—9	9—11	11—13	13—15	Totals
Emmetropia	23	66	84	73	24	270
Hypermetropia	37	46	56	48	19	206
Hypermetropic Astigmatism	20	30	18	28	12	108
Mixed Astigmatism	15	7	9	5	3	39
Myopic Astigmatism and Myopia	—	5	8	10	5	28
Totals	95	154	175	164	63	651

* The Tables XX and XXI are drawn from the "Summary of Facts," under column "Eyes." In these detailed accounts of individual children apparently a less stringent standard of defective sight was taken, many children being recorded as normal in whom slight amounts of hypermetropia, or myopia or astigmatism occurred. Tables XX *bis* and XXI *bis* are taken from Table XI "Eyes," of the Tables of Medical Inspection, and they represent a more stringent classification. In the same way the Keenness of Vision results in Tables XXXII and XXXIII taken from the "General Summary" differ, but to a less extent, from the Table XI of the Medical Inspection just referred to.

TABLE XXI *bis*. *Refraction Class and Age. Edinburgh Girls.*

Refraction Class	Age					
	5—7	7—9	9—11	11—13	13—15	Totals
Emmetropia	16	45	72	47	23	203
Hypermetropia	28	40	49	19	12	148
Hypermetropic Astigmatism	41	34	27	27	8	137
Mixed Astigmatism	16	9	4	9	3	41
Myopic Astigmatism and Myopia	1	8	9	17	2	37
Totals	102	136	161	119	48	566

TABLES XXII AND XXIII. *Refraction Class and Age. Glasgow.*

Refraction Class	Boys				Girls			
	Age				Age			
	6—9	9—12	12—15	Totals	6—9	9—12	12—15	Totals
Emmetropia	33	60	29	122	52	70	27	149
Hypermetropia	8	22	25	55	3	15	16	34
Hypermetropic Astigmatism	3	11	9	23	2	8	10	20
Mixed Astigmatism	—	3	5	8	—	7	5	12
Myopic Astigmatism and Myopia	2	3	7	12	6	1	6	13
Totals	46	99	75	220	63	101	64	228

TABLE XXIV. *Refraction Class and Age. London Boys**.

Refraction Class	Age							
	7—8	8—9	9—10	10—11	11—12	12—13	13—14	Totals
Hypermetropia	11	24	22	20	32	37	28	174
Hypermetropic Astigmatism	12	35	37	24	26	27	25	186
Mixed Astigmatism	8	40	24	25	26	27	22	172
Myopia and Myopic Astigmatism	9	33	27	31	43	47	56	246
Totals	40	132	110	100	127	138	131	778

TABLE XXV. *Refraction Class and Age. London Girls**.

Refraction Class	Age							
	7—8	8—9	9—10	10—11	11—12	12—13	13—14	Totals
Hypermetropia	10	35	34	32	36	64	52	263
Hypermetropic Astigmatism	15	33	30	35	26	39	25	203
Mixed Astigmatism	14	40	30	31	48	30	35	228
Myopia and Myopic Astigmatism	12	27	38	41	45	57	40	260
Totals	51	135	132	139	155	190	152	954

In order to reduce the material the method of contingency was first applied and we obtained the results given in Table XXVI.

Thompson's data, except in so far as they confirm the result that the refraction class is correlated with age, are of little service, since they exclude the normals. It will be clear that the correlation between age and refraction class is about ·20—·25

* Assuming these Tables to give the whole numbers of defective refraction cases in 10,416 boys and 11,498 girls, we have the following percentages from Thompson's Tables:

	Boys	Girls
"Normals"	92·5	91·7
Hypermetropia	1·7	2·3
Hypermetropic Astigmatism	1·8	1·7
Mixed Astigmatism	1·7	2·0
Myopic Astigmatism and Myopia	2·3	2·3

Thus it will be seen that while all the defective categories are below the Scottish, it is the Hypermetropia and Hypermetropic Astigmatism which in the Scottish returns so vastly exceed the English. Thompson allowed anything under 2 diopters in Hypermetropia to be "normal." We are not told what was used at Edinburgh. In Glasgow 1 diopter was the test. Rowan and Thompson both used 1 D for Hypermetropic Astigmatism, Mixed Astigmatism and Myopia. This difference in the test for Hypermetropia explains partly but far from entirely the great divergence between the English and Scottish results.

for boys and somewhat greater, ·30 to ·35, for girls. This is quite a sensible amount and should have some influence on the values of fraternal correlation. If we may

TABLE XXVI. *Refraction and Age.*

Characters	Material	Method	♂	♀
Corneal Refraction	Zürich (Steiger: see our p. 15)	Product Moment	·17	·16
Refraction Class	Edinburgh	Contingency	·25 (·17)*	·34 (·28)*
,, ,,	Glasgow (Rowan)	,,	·27	·36
,, ,,	London (Thompson)	,,	·21	·17

accept the values deduced from Steiger's material, the effect of age on corneal refraction is not the sole source of the high value between refraction class and age. It should be noticed, however, that Steiger's material only provides three age groups, one of which is adult.

We can arrange our material in two other ways which show less concisely the relationship of age to refraction class.

TABLE XXVII. *Mean Age of each Refraction Class.*

Refraction Class	Edinburgh		Glasgow		London	
	Boys †	Girls †	Boys	Girls	Boys	Girls
Emmetropia	10·1 (10·0)	9·7 (10·2)	10·4	10·0	?	?
Hypermetropia	9·6 (9·6)	9·3 (9·3)	11·4 } 11·4	11·6 } 11·6	11·0 } 10·8	11·2 } 10·9
Hypermetropic Astigmatism	9·7 (9·7)	8·9 (8·9)	11·3	11·7	10·6	10·7
Mixed Astigmatism	9·1 (8·7)	8·3 (8·7)	12·4	11·75	10·6	10·8
Myopic Astigmatism	10·7 } (11·1)	10·3 } (10·6)	13·5 } 11·7	} 10·5	} 11·3	} 11·0
Myopia	10·9	10·7	10·9			
All Children	10·0 (9·9)	9·5 (9·6)	10·9	10·5	10·9 ?	10·9 ?

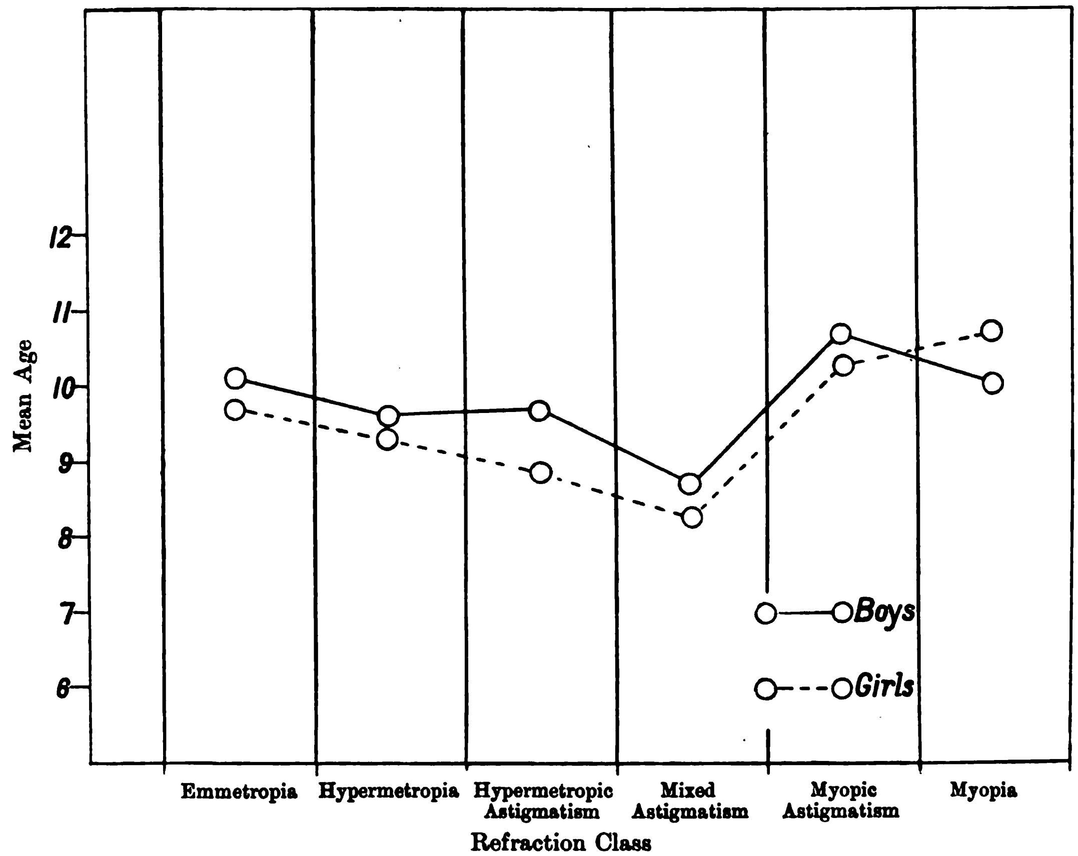
The Edinburgh data (see Diagram II) appear here to give the smoothest and most reasonable results, namely the hypermetropic and mixed astigmatic are below the mean age; the myopic are above and the normals at the mean age. Rowan and Thompson's abnormals give the myopic at or above the mean age, but do not indicate decisively that the hypermetropic are below the mean age. To obtain any very definite

* The first values are from Tables XX and XXI, and the bracketed values from Tables XX *bis* and XXI *bis*.

† The figures in brackets are from Tables XX *bis* and XXI *bis*, and serve to confirm the other results.

DIAGRAM II.

Change of Refraction Class with Age.

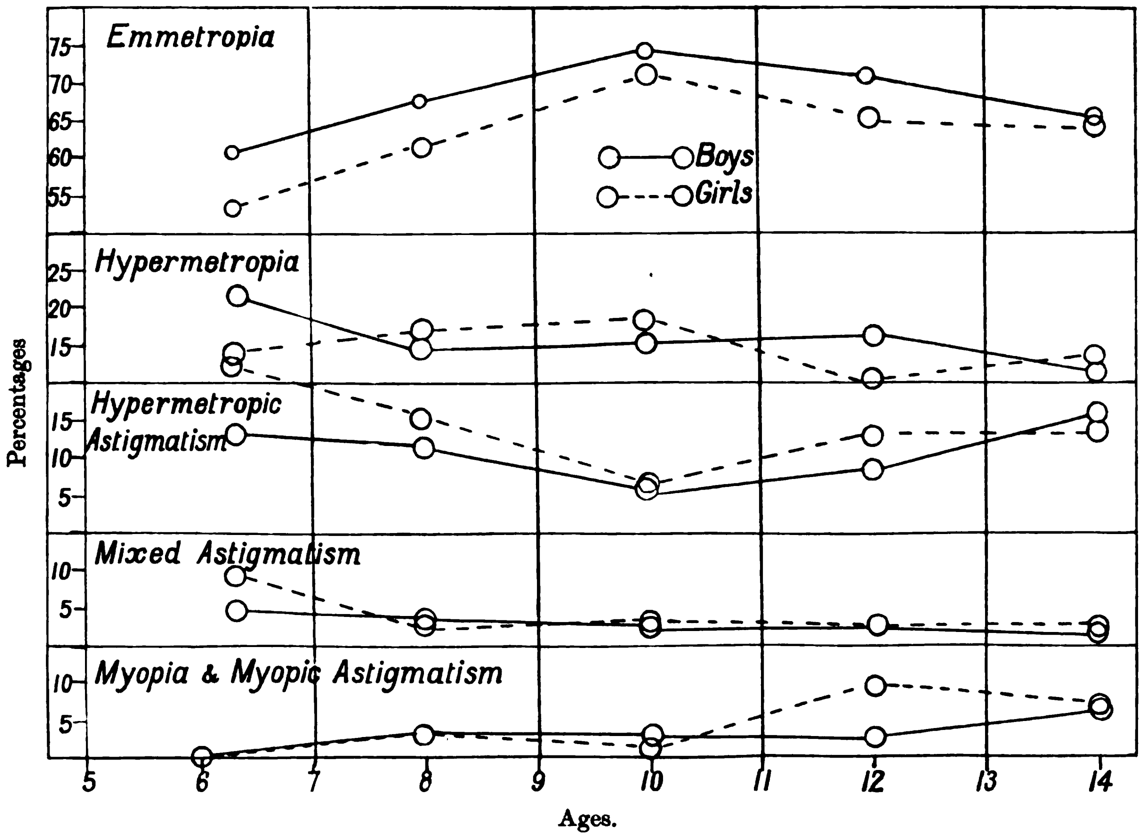


results from this method of approaching the problem much larger numbers would be required. We may also consider the problem from the standpoint of the percentages of each class at each age (Tables XXVIII and XXIX). Thompson's statistics cannot be dealt with as we have not the number of normals at each age. He found 778 cases of defective vision on a register of 10,416 boys and 954 on a register of 11,498 girls. In Edinburgh 204 cases of defective sight occurred among 659 boys and 202 among 553 girls; in Glasgow 98 among 220 boys and 79 among 228 girls. Hence either defects of refraction are far greater in number among the Scotch, or a much higher standard of what ought to be classified as emmetropia was used in Scotland. On both counts: the absence of normals and the wide difference of percentages, it does not seem possible to compare Thompson's with our other data. Unfortunately Rowan's data only provide three age classes.

Now if we were to take the Glasgow results as typical we should certainly have an apparently very bad case against school environment. It amounts to asserting that normal eye-sight decreases by almost 50 % between 6 and 15 years of age, and that

DIAGRAM II *bis*.

Age and Percentages of each Refraction Class.



The above diagram shows graphically the results of Tables XXVIII and XXIX. The reader will see at once the rapid gain in Emmetropia between the ages of 6 and 10, and recognise that this gain must be chiefly due to the loss in the hypermetropic categories. The partial fall again in the Emmetropia is due to two sources: (i) a rise in the amount of Myopia and Myopic Astigmatism, and (ii) a hardly less serious rise in the Hypermetropic Astigmatism. The Hypermetropia itself continues to fall and there is but little change after the age of 8 in the mixed Astigmatism.

To face p. 31.

TABLE XXVIII. *Percentages at each Age of each Class. Boys.*

Refraction Class	Age. Edinburgh						Age. Glasgow			
	4—7	7—9	9—11	11—13	13—15	All ages	6—9	9—12	12—15	All ages
Normal	60·7	67·5	74·4	70·8	65·1	69·05	71·7	60·6	38·7	55·5
Hypermetropia	21·3	14·5	15·0	16·1	11·1	15·6	17·4	22·2	33·3	25·0
Hypermetropic Astigmatism	13·5	11·4	5·6	8·1	15·9	9·7	6·5	11·1	12·0	10·4
Mixed Astigmatism	4·5	3·6	2·2	2·5	1·6	2·9	0·0	3·0	6·7	3·6
Myopia and Myopic Astigmatism	0·0	3·0	2·8	2·5	6·3	2·75	4·4	3·0	9·3	5·5

TABLE XXIX. *Percentages at each Age of each Class. Girls.*

Refraction Class	Age. Edinburgh						Age. Glasgow			
	5—7	7—9	9—11	11—13	13—15	All ages	6—9	9—12	12—15	All ages
Normal	53·3	61·5	70·9	65·0	64·5	63·5	82·5	69·3	42·2	65·3
Hypermetropia	14·3	17·0	18·6	10·3	13·3	15·1	4·8	14·9	25·0	14·9
Hypermetropic Astigmatism	22·9	15·5	6·6	12·7	13·3	13·7	3·2	7·9	15·6	8·8
Mixed Astigmatism	9·5	3·0	2·6	2·6	2·2	3·9	0·0	6·9	7·8	5·3
Myopia and Myopic Astigmatism	0·0	3·0	1·3	9·4	6·7	3·6	9·5	1·0	9·4	5·7

practically every form of eye defect increases, especially the hypermetropic*. The Edinburgh data show that it is only in the young children, possibly in those below Rowan's minimum age, that there are reductions in the two hypermetropic contingents, which apparently swell the number of normal eyes. After the earlier ages, however, hypermetropic astigmatism steadily increases in the Edinburgh as well as in the Glasgow series. This increase is almost as marked as in the myopic class and shows that the conclusion reached by Thompson, namely: that there is a decrease of hypermetropic astigmatism with age, is not universally true†. The enormous increase in defective sight indicated by Rowan is not borne out by the Edinburgh material; we find at Edinburgh a larger number of normals between 13—15 than between 4—7, although the maximum of emmetropia is reached between 9—11. From the merely statistical standpoint the Edinburgh data appear to be the smoother and the more self-consistent. But we venture to think that while there is not the least doubt of a sensible relationship of age to each of the several categories of eye defect, yet the problem of the nature of this age relationship has not at present been properly

* It is significant that the London, Glasgow and Edinburgh statistics agree in not showing the marked decrease in hypermetropia with age, which has been recorded in German and Russian returns. Is this a real national difference, or due to the use of different standards of emmetropia?

† His proof is not statistically valid, as the percentages ought to have been based on the number examined at each age. See our p. 3.

thrashed out. As long as such widely divergent results as those provided by London, Edinburgh and Glasgow remain unreconciled, we are not in a position to determine how far: (i) simple growth and (ii) environment, especially school environment, affect the refractive power of the eyes. It will not be easy to separate (i) from (ii). The Edinburgh statistics seem to show that school life—taking the range 5 to 15 years—does not increase the total amount of defective sight, the Glasgow data show that it nearly doubles it. Comparing the London and Glasgow data we see either (*a*) that the Scottish race has very much worse eyesight than the English, or (*b*) that the Scottish ophthalmologist takes a much higher standard for emmetropia*. As far as it

* In forming our Tables XX and XXI we have taken our material straight from the "Summary of Facts regarding Home Life and Health of Children," Plate 5 et seq. In this summary, as we have already remarked, a wider range has been given to "Normal" than to the term "Emmetropic" in the Medical Summary in the Edinburgh Report, Table XI. The latter table shows more cases of hypermetropia, myopia, and astigmatism than appear under the description in the summary of each individual child. Table XI of the Report reduced to percentages gives us Tables XXX and XXXI:

TABLE XXX. *Percentage at each Age of each Refraction Class. Boys.*

Refraction Class of 651 Boys	Age					Totals
	5—7	7—9	9—11	11—13	13—15	
Emmetropia	24·2	42·9	48·0	44·5	38·1	41·5
Hypermetropia	38·9	29·9	32·0	29·3	30·1	31·6
Hypermetropic Astigmatism	21·1	19·5	10·3	17·1	19·0	16·6
Mixed Astigmatism	15·8	4·5	5·1	3·0	4·8	6·0
Myopic Astigmatism	0·0 } 0·0	1·9 } 3·2	2·3 } 4·6	4·3 } 6·1	4·8 } 8·0	2·6 } 4·3
Myopia	0·0	1·3	2·3	1·8	3·2	1·7

TABLE XXXI. *Percentage at each Age of each Refraction Class. Girls.*

Class of 566 girls	Age					Totals
	5—7	7—9	9—11	11—13	13—15	
Emmetropia	15·7	33·1	44·7	39·5	47·9	35·9
Hypermetropia	27·4	29·4	30·4	16·0	25·0	26·1
Hypermetropic Astigmatism	40·2	25·0	16·8	22·7	16·7	24·2
Mixed Astigmatism	15·7	6·6	2·5	7·6	6·2	7·2
Myopic Astigmatism	1·0 } 1·0	2·2 } 5·9	3·1 } 5·6	6·6 } 14·2	4·2 } 4·2	3·4 } 6·6
Myopia	0·0	3·7	2·5	7·6	0·0	3·2

These percentages confirm the results previously deduced, i.e. there is less defect at 9—11 than at earlier ages, and if school from 10 to 15 does damage sight, yet at 15 there is less bad sight than when the children first come to school. Hypermetropic Astigmatism tends to increase after the 9—11 group, at least for boys; Hypermetropia remains fairly constant after this age, so does Mixed Astigmatism, but Myopia increases.

is legitimate to draw conclusions at all, our Edinburgh data would thus lead us to say, that a great deal of hypermetropia, hypermetropic and mixed astigmatism disappears, probably owing to growth, between 6 and 10, thus swelling the number of emmetropic eyes; that after this age there is not sufficient evidence to say whether these categories remain steady or slightly vary. Myopia and myopic astigmatism increase throughout, but this increase does not balance the total gain, due to rectification by growth; thus on leaving school there are more normal sighted individuals than on entering it. This is not in accordance with Rowan's Glasgow data, but the number of eyes dealt with by him was comparatively small and there were probably special conditions connected with his Glasgow school.

An almost similar result to the above was reached long ago by Erismann* who gave the data reproduced in Table XXXII below, which, although it exhibits some carelessness in calculating percentages, still tells precisely the same tale.

Here we have with different absolute numbers the same increase during school life of the emmetropic class, owing to the decrease of hypermetropia, so that at the end of school life there are practically as many emmetropic as at the start of school life, the change taking place by the hypermetropic having passed through emmetropia to myopia, which has increased in amount to three times its original

TABLE XXXII. *School Class.*

	I	II	III	IV	V	VI	VII	VIII	IX
Emmetropia	18·6	28	26·4	27·3	26·4	24·2	25	21	18·3
Hypermetropia ...	67·8	55·8	50·5	41·3	34·7	34·5	32·4	36·2	40
Myopia	13·6	15·6	22·4	30·7	38·4	41·3	42	42·8	41·7

prevalency. The absolute percentages are quite incomparable with British data, but they show the same common drift. It would be as reasonable to call the decrease in hypermetropia an effect of school environment as to adduce Erismann's results as evidence of the "hot-bed theory" as expressed on p. 34 below.

* The data are from tests made at St Petersburg in 1871; they are cited by Cohn (*loc. cit.*), who gives further data to the same effect. Erismann's statistics are quoted by Risley in the form of a graph (Norris and Oliver, *System of Diseases of the Eye*, Vol. II. p. 353 et seq.). Risley also gives statistics of his own from Philadelphia schools showing that the amount of emmetropia is not lessened but actually increases from 7·01 °/。 to 12·88 °/。 during school life, the increase in myopia being due to the decrease in hypermetropia. Risley takes strongly the view that the change is pathological and not physiological, and asserts that the hypermetropia will only disappear under the stress of employments which require the protracted use of the eyes at near work. The copious statistics collected by Randal (*American Journal of the Medical Sciences*, July, 1885) contribute little to our present enquiry, as they do not give the age distribution of the population providing the percentages in each local examination. On the whole, notwithstanding different examining standards, these statistics serve to show as markedly as those of Cohn that refraction is a *racial* character. It is difficult to grasp how a character can have racial differentiation and yet be largely free of the hereditary factor.

The conclusion reached above as to change by growth must not be taken as a dogmatic assertion that eyes are not damaged by school environment*. We might have a much larger percentage of normal vision, if there were no school environment; all we can say is that the school influence does not dominate the apparent tendency of the eye to grow normal. Taking the Tables XXX and XXXI in our footnote (pp. 31–2) we may say that the hypermetropic, the hypermetropic-astigmatic and mixed astigmatic classes have for boys decreased by 24 °/₀ and for girls decreased by 36 °/₀, while for boys the myopic and myopic-astigmatic classes have increased by 7 °/₀ and for girls by 8 °/₀. Is it legitimate to assert that the loss of the hypermetropic character is wholly due to natural growth and the gain in myopia to school environment? May not the school environment be partially effective in the former case and natural growth partially contributory in the latter? If so, it will not be possible to establish without much further research a grave charge against school environment on the ground of its effect on eyesight. It may, indeed, be doubted whether the problem can be solved at all until elaborate observations have been made on the children of an uncivilised race at various ages. It would be interesting if an ophthalmologist beyond the range of schools would take up the question; in Africa or in districts of India, the man and the material may possibly yet be found.

To sum up, we have to note that the refractive class does change with age, and accordingly this must influence the hereditary resemblance of brothers, if these brothers are not measured at the same age but at the same epoch. This last is all that our present material provides.

Origin of the "hot-bed" theory. The theory that schools are the real source of short-sightedness is very widespread and some account of its origin and acceptance may not be considered out of place in this paper. The vast bulk of the evidence in its favour is German, and this evidence, were it beyond statistical reproach, is not directly applicable to English conditions. The persistent use by the Germans of non-hygienic characters for their type is based solely on a mistaken notion of patriotism, and possibly a want of historical knowledge. This use renders all comparison of English and German conditions unprofitable†. Fuchs (*loc. cit.* p. 763) writes:

"Schools are the main hot-beds for the propagation of near-sightedness. Cohn by his extensive researches was the first to direct general attention to this fact. New-born children are almost without exception hypermetropic. Near-sightedness is acquired later in life through straining the eyes and hence fails to occur when the strain is absent. Again in the lowest order of schools, the common schools, there are extremely few near-sighted persons and the same is true of the rural population. The school most dangerous to the eyes is the high school. It is in this that myopia develops and then increases both as regards its intensity and the number of myopes in proportion as we ascend the classes. In Germany above

* See the brief critical and historical notes which follow in the next paragraphs.

† It is only the non-German who can properly judge of the effect of German type, and in his case he must compare the result of several days' work on German books in German characters with the like period of work on German books in Roman characters.

20 °/₀ are myopic in the lowest classes of the high schools and 60 °/₀ in the highest classes. In the university the condition of affairs is still more unfavourable. Among lithographers Cohn found 45 °/₀ and among compositors 51 °/₀ to be myopic."

Nothing can better express the environmental theory than this extract, but every fact stated needs cautious consideration. The percentages of myopes in no way apply to England. The savage is stated not to be near-sighted, but then for generations his survival has largely depended on his far-sight*. In the same way a particular class of eye may well be suited to work at a particular trade or profession, or be at least unsuited to other professions†. Extreme short sight unfits a man for the army or navy, but it would be erroneous to attribute to environment the fact that more myopes are to be found among authors than in those outdoor occupations. Again the average age at the university is higher than at the high school, and in this higher than in the common school, and very often it is higher in the urban than in the rural district school. Arguments from school statistics cannot possibly be valid unless the age factor is first allowed for, and the data provided is often too inadequate to admit this‡. It will, we think, be clear that no argument in which (i) the age factor has not been allowed for, and (ii) the problem of possible selection fully considered, is valid when it attributes myopia to a special environment. Even if the increase of myopia with age be really due to environmental conditions, it does not follow that those conditions are summed up in the length of school life.

Curiously enough while Cohn's data are always appealed to when the theory of the school as the "hot-bed for the propagation of short-sightedness" is propounded there are certain statistics of Cohn, which properly investigated, might have caused some hesitation in the acceptance of this doctrine. Cohn gives the distribution of the degrees of myopia for 1004 school children according to (*a*) their ages, (*b*) the number of years of school life§.

We reproduce these tables as Tables XXXIII *a* and XXXIII *b*. Unfortunately Cohn does not give a table correlating age and number of years at school, but

* Survival for an animal may depend on far or near sight, and dogs have been differentiated by their sight in this manner. Compare the dogs that hunt by sight with those that hunt by scent. No one would attribute this difference to direct effect of environment.

† A good illustration of a possible inversion of the cause of association is provided by Emmert, who, finding much eye-defect in four Swiss watchmaking schools, attributed it to muscular irregularity due to the use of the magnifying lens, *this irregularity being especially apt to become hereditary.*

‡ For example an important table for our present purposes is given in Mr Arnold Lawson's *Report on the Vision of Children attending London Elementary Schools* (*British Medical Journal*, June 18, 1898, p. 1614), namely, Table VI. From this table he draws the conclusion that goodness of school construction and the healthy character of the district appear to have little to do with the amount of myopia; but the age distribution of the children in the compared schools, whereby this result might be effectively established, is not available. The same absence of age distribution appears in J. Ackworth Menzies' "The Vision of School Children," *British Medical Journal*, Jan. 14, 1899, p. 77, and in many other publications of an earlier date.

§ *Untersuchungen der Augen von* 10,060 *Schulkindern nebst Vorschlägen zur Verbesserungen der den Augen nachtheiligen Schuleinrichtungen*, S. 51 u. 53, Leipzig, 1867.

we are able to draw a very decided conclusion from the data as it is. If school environment is the source of myopia, then we should expect to find a high relation between degree of myopia and number of years at school. The relationship between age and myopia would only be a secondary result of the relation between age

TABLE XXXIII *a*. *Myopia and Age.*

Degree of Myopia, focal length in inches.

Age	35—24	23—16	15—12	11—8	7	6	Totals
6	5	—	—	—	—	—	5
7	20	3	1	1	—	—	25
8	31	14	5	—	—	—	50
9	39	23	6	2	—	—	70
10	51	34	8	2	—	—	95
11	51	35	10	—	—	—	96
12	74	42	12	8	—	—	136
13	72	48	23	5	2	—	150
14	48	32	22	8	1	1	112
15	29	27	18	12	—	1	87
16	17	22	16	12	—	—	67
17	12	14	14	8	—	—	48
18	8	6	11	13	1	1	40
19	6	3	3	3	—	—	15
20	1	2	—	2	2	—	7
22	—	—	1	—	—	—	1
Totals	464	305	150	76	6	3	1004

TABLE XXXIII *b*. *Myopia and Years of School Life.*

Degree of Myopia, focal length in inches.

No. of Years at School	35—24	23—16	15—12	11—8	7	6	Totals
1—2	93	44	10	4	1	—	152
3—4	99	64	19	4	—	—	186
5—6	126	81	40	7	—	—	254
7—8	96	63	30	28	3	2	222
9—10	31	37	33	20	—	—	121
11—12	15	11	14	11	1	—	52
13—14	4	5	4	2	1	1	17
Totals	464	305	150	76	6	3	1004

and number of years at school. If on the other hand age is the chief source of the relationship we should expect age and degree of myopia to be more closely correlated than number of years of school life and myopia, the association of the latter being then merely a secondary result of myopia increasing with age.

These tables are based on the old system of recording the focal length of the correcting lens. The range of the sub-groups are badly chosen for statistical purposes, and the number of divisions differ considerably in the two cases. Accordingly as the matter is very important three separate methods were used to test the relative degree of relationship between the two pairs of characters, i.e. the correlation coefficients (r), the correlation ratios (η), and the mean square contingency coefficients (C_2)* were found. The results are as follows:

Degree of Myopia and Age.	*Degree of Myopia and Years at School.*
$r = \cdot 331 \pm \cdot 019$,	$r = \cdot 244 \pm \cdot 020$,
$\eta = \cdot 356$,	$\eta = \cdot 319$,
$C_2 = \cdot 364$.	$C_2 = 328$.

Now these values show that the associations between degree of myopia and age and degree of myopia and years of school life, while quite sensible, are not by any means very marked. Further, whichever test be applied it indicates that the relationship between age and degree of myopia is closer than that between the latter and the number of school years. In fact a correlation of ·8 to ·9 between age and number of years of school life would make the association of degree of myopia and years at school for a constant age practically *zero*. Cohn provides no data by which we could determine this correlation of age and school life for his material. But in the London schools the children practically rise a standard a year, and it has been found by Mr Heron that the relationship of standard and age is practically of the above magnitude. Accordingly Cohn's statistics seem to indicate that the moderate association they exhibit between school environment and degree of myopia is solely a secondary result of a primary relation between age and degree of myopia.

This increase of myopia with age may be due to the continued action of some environmental factor or to a growth factor. Cohn's statistics, however, do not demonstrate, as has been assumed by many ophthalmological writers, that school is the hot-bed for the production of myopia. Even with the moderate association now found between degree of myopia and age, we must remember the possibility of some portion of it being spurious, i.e. myopia frequently makes the child backward and thus keeps the child to a later age at school.

(c) *Age and Keenness of Vision.*

For this most interesting relationship we have three sets of data:

(i) Material taken from the Edinburgh Report. Here we have again followed the "Summary of Facts" and find returns for 671 boys and 566 girls. The Report itself, Table XI, "Summary of Medical Evidence," gives somewhat divergent tables. Tables XXXV a and XXXV b contain our material.

* Care was taken to have a table of 20 to 24 compartments in both cases.

(ii) Rowan's Glasgow data. He gives 184 boys and 175 girls, unfortunately only in three age classes. See Tables XXXVI *a* and XXXVI *b*.

(iii) London County Council Report (E), p. 32. The material is from the L. S. B. days. A later report, p. 33, only provides three vision classes, and is hardly suited to bring out the full relationship. These data will be found in Tables XXXVII and XXXVIII.

The collected results are given in Table XXXIV.

TABLE XXXIV. *Age and Keenness of Vision Contingency.*

Data from	Boys	Girls
Edinburgh......	·23	·18
Glasgow.........	·21	·19
London	·17	·12

TABLE XXXV *a*. *Age and Keenness of Vision. Boys, Edinburgh.*

Vision	Age					Totals
	4—7	7—9	9—11	11—13	13—15	
6/6	56	115	142	123	49	485
6/9	17	17	17	13	8	72
6/12	6	10	4	8	—	28
6/18	15	19	11	12	6	63
6/24	2	6	1	2	—	11
6/36 and under	—	2	5	2	3	12
Totals	96	169	180	160	66	671

TABLE XXXV *b*. *Age and Keenness of Vision. Girls, Edinburgh.*

Vision	Age					Totals
	5—7	7—9	9—11	11—13	13—15	
6/6	66	93	113	78	33	383
6/9	18	19	12	20	4	73
6/12	10	8	10	7	5	40
6/18	11	14	13	12	—	50
6/24	2	3	2	3	2	12
6/36 and under	1	2	3	1	1	8
Totals	108	139	153	121	45	566

TABLES XXXVI *a* AND XXXVI *b*. *Age and Keenness of Vision. Glasgow.*

Vision	Boys: Age 6—9	9—12	12—15	Totals	Girls: Age 6—9	9—12	12—15	Totals
6/6	35	64	44	143	37	56	32	125
6/9	4	10	10	24	5	8	6	19
6/12	1	2	1	4	6	6	2	14
6/18	1	3	2	6	2	4	2	8
6/24	1	1	—	2	2	1	1	4
6/36 and under	1	—	4	5	3	—	2	5
Totals	43	80	61	184	55	75	45	175

TABLE XXXVII. *Age and Keenness of Vision. Boys, London.*

Vision	Age 6	7	8	9	10	11	12	13	14 and over	Totals
6/6	9	172	633	1046	1328	1433	1546	1482	389	8038
6/9	15	84	210	220	219	169	173	180	35	1305
6/12	2	23	55	65	81	75	79	89	12	481
6/18	1	10	38	50	63	58	68	60	18	366
6/24	—	4	11	16	21	21	32	21	6	132
6/36	—	1	8	12	12	10	15	17	6	81
6/60 and under	—	—	4	6	4	9	18	21	4	66
Totals	27	294	959	1415	1728	1775	1931	1870	470	10469

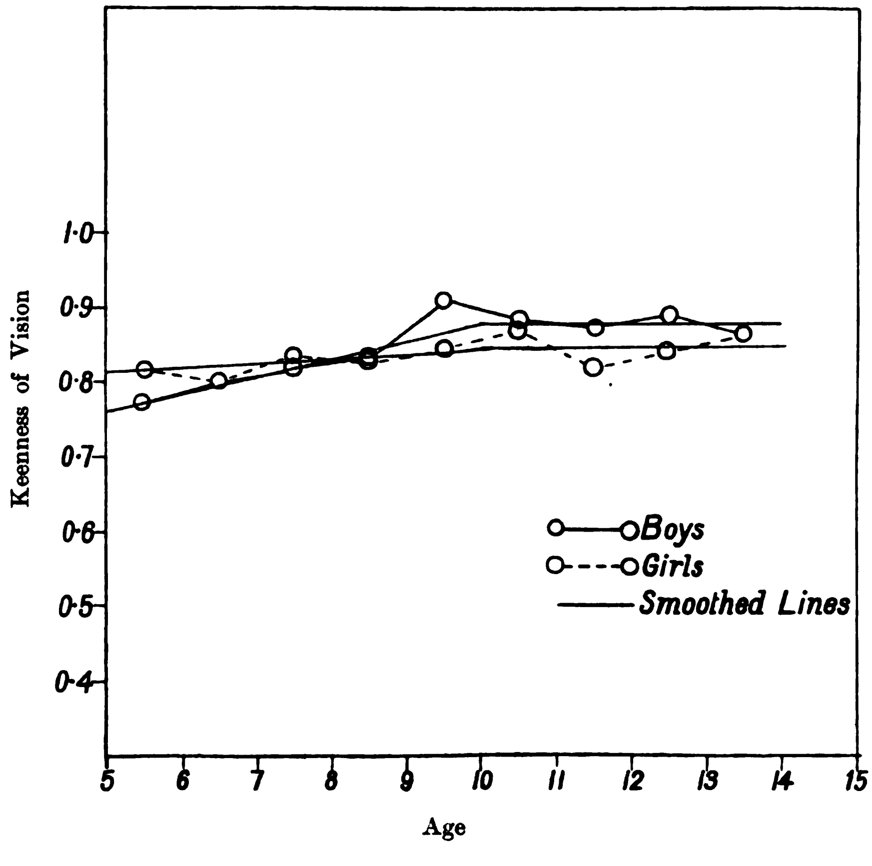
TABLE XXXVIII. *Age and Keenness of Vision. Girls, London.*

Vision	Age 6	7	8	9	10	11	12	13	14 and over	Totals
6/6	23	155	566	887	1268	1356	1439	1243	364	7301
6/9	12	90	199	224	245	232	219	203	51	1475
6/12	4	26	55	93	93	124	96	101	25	617
6/18	1	15	56	59	77	81	93	92	18	492
6/24	—	4	21	21	26	23	40	39	9	183
6/36	—	4	4	13	16	11	19	15	3	85
6/60 and under	—	3	6	12	21	23	20	27	10	122
Totals	40	297	907	1309	1746	1850	1926	1720	480	10275

It will be seen at once that the two sets of Scottish data are in excellent agreement, and although the London material is immensely greater, I believe that on this very account it is not so reliable. I think we may say that the relationship between and age keenness of vision is about ·20, being slightly above this value for boys and below it for girls. It is possible that oncoming puberty in girls disturbs the relationship more than in the case of boys. The London statistics confirm the lesser value for girls.

DIAGRAM III.

Age and Keenness of Vision.



The question now arises: Does goodness of vision increase continuously with age? We find, exactly as we should expect from the refraction results*, that this is not so; there are cross tendencies at work. Taking the boys we see that goodness of vision (Diagram III) increases uniformly up to 9·5 years and then remains stationary. With the girls the increase is less regular and decisive, but this is probably due to the paucity of data. We may look at the matter from the standpoint of percentages as follows:

* i.e. because the correlation between refraction class and vision is so large.

TABLE XXXIX. *Percentages of Good Vision.*

Ages

Vision	Boys						Girls					
	4—7	7—9	9—11	11—13	13—15	All	4—7	7—9	9—11	11—13	13—15	All
Good, 6/6	58·3	68·0	78·9	76·9	74·2	72·3	61·1	66·9	73·8	64·5	73·3	67·7
Fair, 6/9 + 6/12	24·0	16·0	11·7	13·1	12·2	14·9	25·9	19·4	14·4	22·3	20·0	20·0
Bad, 6/18 and over	17·7	16·0	9·4	10·0	13·6	12·8	13·0	13·7	11·8	13·2	6·7	12·3

The boys show exactly the same result here as in the age and refraction classes, i.e. improvement of vision up to 10 and then a falling off, leaving the boy population, however, with better vision on leaving school than when it came. The same remarks apply to the girls although the paucity of data does not enable us to follow clearly the irregularity at 12 and 14; it may possibly have to do with the general physical development of girls at this age.

Thus the Edinburgh statistics seem to show that whether the change at 10 years be peculiar to growth or the effect of school environment, it does not counteract the earlier tendency to improved vision. As far, therefore, as these statistics reach—and the children are not from the best stocks—there does not appear to be definite and conclusive evidence of a markedly bad effect of school life on eyesight.

We may look at this from the standpoint of diseases of the eye and eyelids. Table XI of the Edinburgh Report provides us with the following results:

TABLE XL. *Age and Eye-Disease.*

Ages

	Boys, 715						Girls, 615					
	5—6	7—8	9—10	11—12	13—14	All	5—6	7—8	9—10	11—12	13—14	All
Normal	94	163	171	162	59	649	97	133	150	114	48	542
Diseased	11	15	20	12	8	66	12	19	17	20	5	73
Percentage Diseased	10·5	8·4	10·5	6·9	11·9	9·2	11·0	12·5	10·2	14·9	9·4	11·9

The results are very irregular and show no definite relationship between age and amount of eye-disease*. They present no proof that school environment is in any way responsible for eye disease.

Thus the assertion that school environment is the source of defective vision is not borne out by the Edinburgh statistics, although the sight of these school children is distinctly bad and some forms of eye disease are widely spread.

* They appear to indicate that more female than male children are diseased.

(12) *Heredity as a factor in Refraction Class.* Having seen in the previous section, that the refraction class is correlated with age, and possibly more highly than the simple corneal refraction, we now turn to the heredity factor as far as it concerns refraction class. The Edinburgh data provide 206 pairs of brothers, 162 pairs of sisters, and 325 pairs of brothers and sisters. The tables in the first two cases being made symmetrical gave 412 and 324 pairs respectively.

The relationship was calculated by contingency involving 5 × 5-fold tables and by a fourfold division into emmetropic and ametropic individuals. The results are given in Table XLIV. The actual tables are given as XLI, XLII, XLIII; and the excess or defect of each category from an independent chance distribution in italic figures.

TABLE XLI. *Refraction Class. Brother and Brother.*

		1st Brother					
	Class	Normal	Hypermetropia	Hypermetropic Astigmatism	Mixed Astigmatism	Myopic Astigm. and Myopia	Totals
2nd Brother	Normal	230 (+ *34·2*)	30 (− *17·6*)	15 (− *11·2*)	4 (− *1·5*)	5 (− *4·0*)	284
	Hypermetropia	30 (− *17·6*)	24 (+ *12·4*)	8 (+ *1·6*)	3 (+ *1·7*)	4 (+ *1·8*)	69
	Hypermetropic Astigmatism	15 (− *11·2*)	8 (+ *1·6*)	10 (+ *6·5*)	1 (+ *·3*)	4 (+ *2·8*)	38
	Mixed Astigmatism	4 (− *1·5*)	3 (+ *1·7*)	1 (+ *·3*)	0 (− *·16*)	0 (− *·25*)	8
	Myopic Astigm. and Myopia	5 (− *4·0*)	4 (+ *1·8*)	4 (+ *2·8*)	0 (− *·25*)	0 (− *·41*)	13
	Totals	284	69	38	8	13	412

TABLE XLII. *Refraction Class. Sister and Sister.*

		1st Sister					
	Class	Normal	Hypermetropia	Hypermetropic Astigmatism	Mixed Astigmatism	Myopic Astigm. and Myopia	Totals
2nd Sister	Normal	168 (+ *33·1*)	23 (− *13·8*)	12 (− *13·8*)	3 (− *4·1*)	3 (− *1·5*)	209
	Hypermetropia	23 (− *13·8*)	18 (+ *8·0*)	11 (+ *4·0*)	3 (+ *1·1*)	2 (+ *·8*)	57
	Hypermetropic Astigmatism	12 (− *13·8*)	11 (+ *4·0*)	12 (+ *7·1*)	4 (+ *2·6*)	1 (+ *·1*)	40
	Mixed Astigmatism	3 (− *4·1*)	3 (+ *1·1*)	4 (+ *2·6*)	0 (− *·4*)	1 (+ *·8*)	11
	Myopic Astigm. and Myopia	3 (− *1·5*)	2 (+ *·8*)	1 (+ *·1*)	1 (+ *·8*)	0 (− *·2*)	7
	Totals	209	57	40	11	7	324

TABLE XLIII. *Refraction Class. Brother and Sister.*

Brother

Sister: Class	Normal	Hypermetropia	Hypermetropic Astigmatism	Mixed Astigmatism	Myopic Astigm. and Myopia	Totals
Normal	190 (+ *24·5*)	23 (– *9·8*)	12 (– *7·6*)	2 (– *4·3*)	0 (– *2·8*)	227
Hypermetropia	23 (– *4·7*)	7 (+ *1·5*)	3 (– *·3*)	5 (+ *3·9*)	0 (– *·5*)	38
Hypermetropic Astigmatism	14 (– *15·9*)	14 (+ *8·1*)	9 (+ *5·5*)	2 (+ *·9*)	2 (+ *1·5*)	41
Mixed Astigmatism	3 (– *3·6*)	1 (– *·3*)	4 (+ *3·2*)	0 (– *·3*)	1 (+ *·9*)	9
Myopic Astigm. and Myopia	7 (– *·3*)	2 (+ *·5*)	0 (– *·9*)	0 (– *·3*)	1 (+ *·9*)	10
Totals	237	47	28	9	4	325

TABLE XLIV. *Resemblance of Siblings in Refraction Class.*

Pair	Contingency (5 × 5)	Correlation (Fourfold)
Brother and Brother ...	·41	·59
Sister and Sister.........	·44	·66
Brother and Sister	·48	·57
Mean......	·44	·61

On examining Table XLIV we notice the relatively higher values obtained by adopting a fourfold division, and we can trace possibly the source of this difference. The fourfold tables are given below:

1st Brother

2nd Brother	Emmetropic	Ametropic	Totals
Emmetropic	230	54	284
Ametropic	54	74	128
Totals	284	128	412

1st Sister

2nd Sister	Emmetropic	Ametropic	Totals
Emmetropic	168	41	209
Ametropic	41	74	115
Totals	209	115	324

Sister \ Brother	Emmetropic	Ametropic	Totals
Emmetropic	190	37	227
Ametropic	47	51	98
Totals	237	88	325

The cross product is swollen because of the considerable number of ametropic pairs in which one brother is hypermetropic and the other myopic. That is to say, under the broader category of ametropia we have classed a number of things as "like," which at first sight are really unlike. If we accept the view that a considerable number of the hypermetropic become merely normal, we could not put this appearance of hypermetropic and myopic siblings down to a growth effect; we should have to say that it was an illustration of the principle of the correlation of "unlike imperfections" in heredity*. Examining the italic figures in Tables XLI—XLIII we find: (i) that a normal individual has always brothers and sisters with a defect of frequency in the hypermetropic and myopic classes. (ii) That hypermetropic brothers have a defect of normal brothers and not only an excess of hypermetropic brothers but of brothers with mixed astigmatism and myopic astigmatism and of myopia. This is also true of the hypermetropic sister's sisters. It is true on the whole—there are certain exceptions, due probably to paucity of data—in the pairs of brothers and sisters. Again a mixed astigmatic or a myopic individual has an excess of hypermetropic or hypermetropic astigmatic brothers and sisters. His or her excess of myopic brothers and sisters is slight and becomes even a defect in the brother-brother table. Now we really want tenfold larger numbers to reach a *definite* conclusion, but taken in conjunction with the facts observed in our discussion of age and refraction class, it does seem possible to make a suggestion of the following character. The fact that hypermetropic eyes decrease in number with age and the myopic increase, whereas the hypermetropic individual has a redundancy of myopic siblings, suggests that there are two broad classes of eyes in children, those that vary their refraction and those that do not. The former are in infancy hypermetropic and tend to become myopic with age, passing *beyond* the normal stage; the bulk of the normal in infancy do not change. A large part—say $\frac{1}{3}$ of the resemblance between siblings—would thus be due to the fact that pairs of siblings belong to stocks in which the refraction starts normal and remains normal, or to stocks in which a continuous change from hypermetropia to myopia goes on during childhood. This is a suggestion only,

* Pearson, *The Scope and Importance to the State of the Science of National Eugenics*, p. 38. Note also Risley's very definite statement: "Myopic children have quite as frequently had parents afflicted with hypermetropic as myopic refraction. It is rare, however, to find myopic children in families where both parents have normal eyes." (Norris and Oliver, *System of Diseases of the Eye*, Vol. II. p. 362.)

but if demonstrated on large numbers would suffice to explain the excess of myopic siblings of hypermetropic individuals. If it were the longer school environment which made the elder sibling myopic, we should expect to find normal brothers with an excess of myopic brothers, but this is not the case, it is essentially the hypermetropic individuals who have this excess.

Of 51 cases in which one of a pair of siblings was hypermetropic or possessed hypermetropic astigmatism and the other sibling myopia, myopic astigmatism or mixed astigmatism, the *younger* sibling was the hypermetropic individual in 30 cases and the elder in 21 cases only. This is not conclusive, but it indicates that the suggestion is worth fuller consideration.

Finally it may be noted that we have worked out the partial correlation coefficient between refraction classes of two brothers for constant age of each. This required the following additional coefficients:

Correlation of ages of two brothers $= \cdot 65$.

$$\left.\begin{array}{l}\text{Correlation of age of elder and refraction of younger } = \cdot 18 \\ \text{Correlation of age of younger and refraction of elder } = \cdot 29\end{array}\right\} \text{Mean } \cdot 23.$$

If $\bar{r}_{12}$ be the correlation between refraction classes of the two brothers as observed and r_{12} the value for constant ages, then in round numbers, using the value $\cdot 2$ for age and refraction correlation*,

$$r_{12} = 1\cdot 05\bar{r}_{12} - \cdot 051.$$

Hence if $\bar{r}_{12} = \cdot 44$, the corrected coefficient would be $\cdot 41$, and if $\bar{r}_{12} = \cdot 61$, the corrected fraternal correlation would be $\cdot 59$. I do not think, however, that this method of making the correction, even if it were more sensible, is valid, because the effect of change with age is not a simple proportional change, and we cannot assert that either the contingency or the correlation values of the fraternal resemblance is the true quantitative measure. We can only conclude that the effect of change with age will probably not largely modify the observed relationship between siblings, and the values obtained for this relationship lie on either side of the average value found for fraternal resemblance in a variety of other human characters.

(13) *Heredity as a factor in Keenness of Vision.* Tables XLV—XLVII give the relationship between siblings for keenness of vision drawn from the Edinburgh "Summary of Facts." We have seen that keenness of vision is closely related to refraction class, although it is far from being wholly determined by it. Hence we should expect some resemblances between the contingency tables for refraction classes and keenness of vision, but again also certain special divergencies. On the whole refraction class appears a more definite character than keenness of vision, and the inheritance of it is more marked. Thus the fact that myopics have an excess of hypermetropic siblings appears in the keenness of vision tables as individuals of bad vision having siblings of moderate vision. If we were able to take siblings when they reached fourteen years of age, we should probably find a larger number of pairs with

* If we use the value $\cdot 3$, we get $r_{12} = 1\cdot 10\bar{r}_{12} - \cdot 074$, but precisely the same final values $\cdot 41$ and $\cdot 59$.

TABLE XLV. *Keenness of Vision. Brother and Brother.*

1st Brother (columns); 2nd Brother (rows)

2nd Brother	6/6	6/9	6/12	6/18	6/24	6/36 & under	Totals
6/6	252	21	9	28	5	3	318
6/9	21	12	2	4	2	—	41
6/12	9	2	2	2	1	1	17
6/18	28	4	2	6	—	1	41
6/24	5	2	1	—	—	—	8
6/36 & under	3	—	1	1	—	—	5
Totals	318	41	17	41	8	5	430

1st Brother (columns); 2nd Brother (rows)

2nd Brother	Normal	Defective	Totals
Normal	252	66	318
Defective	66	46	112
Totals	318	112	430

TABLE XLVI. *Keenness of Vision. Sister and Sister.*

1st Sister (columns); 2nd Sister (rows)

2nd Sister	6/6	6/9	6/12	6/18	6/24	6/36 & under	Totals
6/6	184	21	14	18	5	1	243
6/9	21	14	3	3	—	—	41
6/12	14	3	8	3	1	—	29
6/18	18	3	3	4	2	—	30
6/24	5	—	1	2	—	—	8
6/36 & under	1	—	—	—	—	2	3
Totals	243	41	29	30	8	3	354

1st Sister (columns); 2nd Sister (rows)

2nd Sister	Normal	Defective	Totals
Normal	184	59	243
Defective	59	52	111
Totals	243	111	354

TABLE XLVII. *Keenness of Vision. Brother and Sister.*

Brother (columns); Sister (rows)

Sister	6/6	6/9	6/12	6/18	6/24	6/36 & under	Totals
6/6	195	19	7	17	7	2	247
6/9	18	9	1	7	1	—	36
6/12	12	2	1	—	—	1	16
6/18	23	5	2	4	—	1	35
6/24	4	—	—	—	—	—	4
6/36 & under	4	—	1	—	—	—	5
Totals	256	35	12	28	8	4	343

Brother (columns); Sister (rows)

Sister	Normal	Defective	Totals
Normal	195	52	247
Defective	61	35	96
Totals	256	87	343

very bad vision, and the effect of this would be to emphasise the resemblance in the manner in which it is emphasised in the sister-sister case, where two pairs both with bad vision alone produce a most marked effect on the contingency. There is little doubt, I think, that young adults would give better results than pairs of children with ages ranging from 6 to 15, the period during which growth changes are so marked. Still we can only make the best of such material as is at present available, and this shows a marked resemblance between siblings even in keenness of vision. In forming the fourfold tables, we have grouped together all with 6/6 vision and all with less vision.

TABLE XLVIII. *Inheritance of Keenness of Vision.*

Class	Contingency (6 × 6)	Fourfold Correlation Table
Brother-Brother......	·32	·34
Sister-Sister	·58	·36
Brother-Sister	·29	·27
Mean......	·40	·33

The values are less than those for refraction class and this was to be expected, as the sources of defective vision are more general.

If we attempt to allow some correction for age we find that there is no correlation between age of elder brother and keenness of vision of younger; the correlation between age of younger brother and keenness of vision is again small but negative and probably is due only to random sampling. We have therefore for the partial correlation coefficient for constant ages:

$$r_{12} = \frac{\bar{r}_{12}(1-\rho_1^2)+\rho_1\rho_2^2}{1-\rho_1^2-\rho_2^2}$$

where ρ_1 = correlation of ages of siblings = ·65

ρ_2 = correlation of age and keenness of vision = ·2 about.

Thus we have:

$$r_{12} = 1{\cdot}0744\,\bar{r}_{12} + {\cdot}049$$

leading to r_{12} = ·48 and r_{12} = ·40 from the contingency and fourfold mean results respectively.

Without laying any stress on these special numerical values I think we may take it that they generally confirm the previous conclusion: that the physical characters of the eye are hereditary qualities, and that the intensity of inheritance is probably exactly the same as that for other physical characteristics in man.

The special difficulty of these school data is that young children are undergoing growth changes in the refractive powers of the eye, and we are comparing children at

different ages, without at present any sufficiently accurate knowledge of the law of growth (or influence of growth in conjunction with environment, if this view be preferred). Such knowledge can only be satisfactory when a large number of the same children have been *individually* tested year by year from the age 5—6 to 14—15. Even then, for the scientific purposes of heredity, it might be more satisfactory to take young adults and avoid the growth correction altogether.

Summing up our total results for heredity we may say: that the correlations due to the heredity factor amount to about ·4 to ·6.

(14) *Influence of Environment on Sight.* In the previous sections we have seen that notwithstanding a disturbing growth factor with a correlation between age and sight of about ·2, the heredity factor is perfectly definite and compatible in value with other physical inheritance. We have seen reasons for questioning whether the school environment is really very prejudicial to sight, and the suggestion has been made that the age changes are not due or largely due to school influence, but to the fact that possibly eyes consist of two classes, one type of stock having fairly steady normality of refraction, the other tending to pass from hypermetropia to normal and to overshoot the normal and pass into myopia. We might speak of such stocks as stocks of stable and unstable refraction respectively, and their existence would, if established, tend to elucidate several points in age-change and the resemblance of siblings.

We now pass to the next stage of our enquiry. Are the environmental factors, as far as we can trace them, at all comparable with the influence of heredity? We have most heartily to thank our colleague, Miss Ethel M. Elderton, for much assistance in preparing the tables and working out the constants for this part of the discussion.

The following are the characters which were chosen as possibly affecting sight, combined we shall speak of them as the "home environment."

(*a*) Number of people per room of the home. This information is given in the Edinburgh data. Of course the size of the rooms which we do not know may form an important element. Still in a general sort of manner we have a measure of the space in the homes in this character.

(*b*) Economic condition of the home; we divided the homes by the information given in the "Summary of Facts" as to wages, appearance of home, etc., from employer, police, charity officials and others. Of course the division is subject to personal equation and can only be an approximate one, but it suffices as a rough estimate of the influence of poverty on eyesight.

(*c*) We next divided the parents by their physical condition into good or bad, in order to get some measure of the influence of the health of parents on the childrens' eyesight. The Report states whether they are broken down in health, suffering from tuberculosis, etc. Persistent alcoholism was included in bad physique.

(*d*) Moral condition of parents. The chief difficulty here is how far alcoholism is to be treated as a moral or physical complaint. Generally we treated presence

of illegitimate children, loose living of husband or wife or the known nature of their house, frequent appearance before the police magistrate, or conviction for crimes as evidence of bad moral condition of the home. Thus "conviction for brutal assault on wife," "house a regular brothel" would lead us to place a "heavy drinker" in the category of moral failure. Drinking in itself was in the parents of these children so prevalent that it is impossible to take it as determining in itself bad moral conditions. "Man a good workman but goes on spree from time to time, is in two thrift clubs and attends church," or "old soldier and widower who takes a nip now and then, but is good to his girls,—very nice, tidy clean people" can hardly suffice for placing the described in the category of moral failure. On the other hand:

"Very dirty untidy home.... Man teetotal, keeps well at his work.... China and clothes lying piled about room, thick with dust; air very bad. Children sickly (eldest imbecile); wife a slattern,"—

seems to be a case where there is a moral deficiency likely to affect the condition of the children. But, as we have said, we have had to trust in each case to personal judgment in classifying, and while we believe the bulk of cases would be put in the same categories if we went through the data again, it is possible that in some doubtful cases our judgment would not be the same. We think, however, that our classification will amply suffice to show whether there is any *high* degree of association between eye defect and the home environment as represented by overcrowding, poverty, physical health of parents or their moral delinquency. Tables XLIX—LXIV give the tabulated data, and Table LXV sums up the results. In some cases the value of the relationship has been reached by two different methods. It will be seen at once that the influence of home environment is very slight, in some cases insensible.

TABLE XLIX. *Refraction Class and Persons per Room. Boys.*

Refraction Class	Persons per Room: 1 and 2	3	4	5	6, 7, 8, and 'overcrowded'	Totals
Normal	115·5 (−*1·2*)	164 (−*2·0*)	91 (+*3·4*)	31·5 (−*2·0*)	45 (+*1·9*)	447
Hypermetropia	22·5 (−*4·1*)	40 (+*2·1*)	21 (+*1·0*)	7·5 (−*0·2*)	11 (+*1·2*)	102
Hypermetropic Astigmatism	23·5 (+*6·5*)	22 (−*2·1*)	9·5 (−*3·2*)	7 (+*2·1*)	3 (−*3·3*)	65
Mixed Astigmatism	5 (−*0·5*)	9 (+*1·2*)	3·5 (−*0·6*)	0·5 (−*1·1*)	3 (+*1·0*)	21
Myopia & Myopic Astigmatism	4 (−*0·7*)	7·5 (+*0·8*)	3 (−*0·5*)	2·5 (+*1·2*)	1 (−*0·7*)	18
Totals	170·5	242·5	128	49	63	653

TABLE L. *Refraction Class and Persons per Room. Girls.*

Persons per Room

Refraction Class	1 and 2	3	4	5	6, 7, 8, and 'overcrowded'	Totals
Normal	80·5 (*−5·9*)	113 (*−5·7*)	84·5 (*+7·2*)	36 (*+2·4*)	33 (*+2·0*)	347
Hypermetropia ...	24 (*+3·3*)	25 (*−3·4*)	18·5 (*−0·0*)	7·5 (*−0·5*)	8 (*+0·6*)	83
Hypermetropic Astigmatism	20·5 (*+1·3*)	34·5 (*+8·2*)	10 (*−7·1*)	6 (*−1·5*)	6 (*−0·9*)	77
Mixed Astigmatism	6 (*+0·5*)	6·5 (*−1·0*)	6 (*+1·1*)	2·5 (*+0·4*)	1 (*−1·0*)	22
Myopia & Myopic Astigmatism	5·5 (*+0·8*)	8·5 (*+2·0*)	3 (*−1·2*)	1 (*−0·8*)	1 (*−0·7*)	19
Totals	136·5	187·5	122	53	49	548

TABLE XLIX *bis. Boys.*

Persons per Room

Refraction Class	1—3	4 and more	Totals
Normal ...	279·5	167·5	447
Ametropic	133·5	72·5	206
Totals ...	413	240	653

TABLE L *bis. Girls.*

Persons per Room

	1—3	4 and more	Totals
Normal ...	193·5	153·5	347
Ametropic	130·5	70·5	201
Totals ...	324	224	548

TABLE LI. *Keenness of Vision and Persons per Room. Boys.*

Persons per Room

Vision	1 and 2	3	4	5	6, 7, 8, etc.	Totals
Normal	133·5 (*+4·5*)	162·5 (*−9·6*)	105 (*+8·7*)	32·5 (*−3·4*)	46·5 (*−0·2*)	480
6/9	23·5 (*+3·9*)	27·5 (*+1·3*)	10 (*−4·6*)	5·5 (*+0·0*)	6·5 (*−0·6*)	73
6/12	6·5 (*−1·0*)	10 (*−0·0*)	4·5 (*−1·1*)	3 (*+0·9*)	4 (*+1·3*)	28
6/18	13·5 (*−3·7*)	28·5 (*+5·6*)	9·5 (*−3·3*)	7·5 (*+2·7*)	5 (*−1·2*)	64
6/24 and under	2·5 (*−3·7*)	11 (*+2·8*)	5 (*+0·4*)	1·5 (*−0·2*)	3 (*+0·8*)	23
Totals...	179·5	239·5	134	50	65	668

TABLE LII. *Keenness of Vision and Persons per Room. Girls.*

Persons per Room

Vision	1 and 2	3	4	5	6, 7, 8, etc.	Totals
Normal	89 (− *7·5*)	129 (− *3·1*)	92 (+ *6·6*)	34 (− *2·3*)	38 (+ *6·4*)	382
6/9	21 (+ *2·1*)	26 (+ *0·1*)	15·5 (− *1·3*)	8·5 (+ *1·4*)	4 (− *2·2*)	75
6/12	13·5 (+ *3·7*)	13 (− *0·5*)	6·5 (− *2·2*)	6 (+ *2·3*)	0 (− *3·2*)	39
6/18	13·5 (+ *0·1*)	22 (+ *3·7*)	10·5 (− *1·4*)	4 (− *1·0*)	3 (− *1·4*)	53
6/24 and under	6·5 (+ *1·7*)	6·5 (− *0·1*)	2·5 (− *1·8*)	1·5 (− *0·3*)	2 (+ *0·4*)	19
Totals...	143·5	196·5	127	54	47	568

TABLE LI *bis. Boys.*

Persons per Room

Vision	1—3	4 and more	Totals
Normal...	296	184	480
Abnormal	123	65	188
Totals ...	419	249	668

TABLE LII *bis. Girls.*

Persons per Room

Vision	1—3	4 and more	Totals
Normal...	218	164	382
Abnormal	122	64	186
Totals ...	340	228	568

Refraction Class and Economic Condition of Home.

TABLE LIII. *Boys.* TABLE LIV. *Girls.*

Refraction Class	Economically good (Boys)	Economically bad (Boys)	Totals (Boys)	Economically good (Girls)	Economically bad (Girls)	Totals (Girls)
Normal	233	215	448	163	184	347
Hypermetropia...	48	55	103	43	40	83
Hypermetropic Astigmatism	36	29	65	38	39	77
Mixed Astigmatism	8	13	21	16	6	22
Myopic Astigmatism & Myopia	11	7	18	13	6	19
Totals.........	336	319	655	273	275	548

In fourfold table separated into normal and ametropic.

Keenness of Vision and Economic Condition of Home.

TABLE LV. *Boys.* TABLE LVI. *Girls.*

Vision	Boys: Economically good	Boys: Economically bad	Boys: Totals	Girls: Economically good	Girls: Economically bad	Girls: Totals
Normal	240	242	482	193	189	382
6/9	36	37	73	44	31	75
6/12	11	17	28	19	20	39
6/18	34	30	64	28	25	53
6/24 and under	13	10	23	4	15	19
Totals......	334	336	670	288	280	568

In fourfold table separated into normal as against 6/9 and under.

Refraction Class and Physical Condition of Parents.

TABLE LVII. *Boys.* TABLE LVIII. *Girls.*

Refraction Class	Boys: Physically good	Boys: Physically bad	Boys: Totals	Girls: Physically good	Girls: Physically bad	Girls: Totals
Normal	199	250	449	155	192	347
Hypermetropia ...	42	57	99	38	46	84
Hypermetropic Astigmatism	30	27	57	32	43	75
Mixed Astigmatism	9	12	21	11	11	22
Myopic Astigmatism & Myopia	6	12	18	8	11	19
Totals.........	286	358	644	244	303	547

In fourfold table separated into normal and ametropic.

The numbers included in Tables XLIX—LXIV vary from table to table; in some cases the refraction or keenness of vision was not definitely stated, in others, it was not possible to determine the home conditions for one or other character with anything like certainty.

If for the moment we confine our attention solely to myopia and myopic astigmatism and again to the worst vision group (6/24 and under) we see that in three out of the four tables XLIX—LII the larger percentage of bad sight comes from the less crowded homes, i.e. homes with 1—3 persons per room.

In all but one of the four tables connecting economic condition and sight

Keenness of Vision and Physical Condition of Parents.

TABLE LIX. *Boys.* TABLE LX. *Girls.*

		Boys: Physically good	Boys: Physically bad	Boys: Totals	Girls: Physically good	Girls: Physically bad	Girls: Totals
Vision	Normal	209	267	476	164	216	380
	6/9	32	39	71	35	39	74
	6/12	11	15	26	14	25	39
	6/18	29	33	62	26	27	53
	6/24 and under	8	15	23	5	15	20
	Totals	289	369	658	244	322	566

In fourfold table separated into normal as against 6/9 and under.

(LIII—LVI) the greater percentage of extreme bad sight, whether of refraction or of vision, comes from the good homes. In the four tables connecting the physical condition of the parents with the bad sight of the children (LVII—LX) a larger percentage of the *extreme* bad sight is associated with physically bad parentage, but a slightly larger percentage of the lesser degrees of defective sight occurs in all cases with the physically good parentage!

Refraction Class and Moral Condition of Parents.

TABLE LXI. *Boys.* TABLE LXII. *Girls.*

		Boys: Morally good	Boys: Morally bad	Boys: Totals	Girls: Morally good	Girls: Morally bad	Girls: Totals
Refraction	Normal	196	253	449	147	200	347
	Hypermetropia	51	48	99	38	46	84
	Hypermetropic Astigmatism	33	24	57	33	42	75
	Mixed Astigmatism	10	11	21	12	10	22
	Myopic Astigmatism & Myopia	9	9	18	8	11	19
	Totals	299	345	644	238	309	547

In fourfold table separated into normal and ametropic.

Keenness of Vision and Moral Condition of Parents.

TABLE LXIII *Boys.* TABLE LXIV. *Girls.*

Vision	Boys: Morally good	Boys: Morally bad	Boys: Totals	Girls: Morally good	Girls: Morally bad	Girls: Totals
Normal	210	266	476	170	210	380
6/9	39	32	71	33	41	74
6/12	12	14	26	14	25	39
6/18	31	31	62	25	28	53
6/24 and under	10	13	23	4	16	20
Totals	302	356	658	246	320	566

In fourfold table separated into normal as against 6/9 and under.

The morally bad homes produce a higher percentage of the very worst class of vision, but this is no longer true for the boys, if we consider 6/18 as bad vision. There is little significance if we consider only the myopia and myopic astigmatism, morally good homes producing the worst sight for boys and morally bad the worst sight for girls. If we include the mixed astigmatism the worst refraction comes in both cases from the good homes.

In every case, considering Table LXV, the correlation of environment and sight is negligible as compared with that of heredity and sight.

TABLE LXV. *Effect of Home Environment on Sight.*

Element of Home Environment	Refraction Class		Keenness of Vision		Mean
	Boys	Girls	Boys	Girls	
Number of Persons per Room	− ·00 (·13)*	− ·15 (·14)*	− ·06 (·14)*	− ·14 (·15)*	− ·09 (·14)*
Good Economic Conditions	+ ·03	− ·12	− ·00	− ·01	− ·02
Good Physical Condition of Parents...	− ·00	+ ·00	− ·00	+ ·00	·00
Good Moral Condition of Parents......	− ·14	− ·05	− ·10	+ ·06	− ·06
Means......	− ·03	− ·08	− ·04	− ·02	− ·04

N.B.—The negative sign throughout means that the worse environment is associated with the better sight.

* Contingency values only possible for this factor, and deduced from somewhat irregular tables. The signs of course must be judged from the bracketted figures in Tables XLIX—LII.

First taking number of persons per room, we note that its influence is very insignificant, but in every case *negative*, i.e. *the more persons per room the better the eyesight.* This may merely mean that the more persons per room the bigger the family and that large families spring generally from more normal stock. At any rate overcrowding does not appear in these data as the source of defective vision. If we examine the contingency tables XLIX—L we shall find generally slight excesses of the normal refraction in the overcrowded rooms and defects in the sparsely filled rooms; on the other hand there appear to be deficiencies of myopia and mixed astigmatism in the crowded rooms and excesses in the sparsely filled rooms. These excesses and deficiencies of frequency are slight, and it would be reasonable to say that for practical purposes no relationship exists*. The same results generally are shown in the contingency tables for keenness of vision. Turning to good economic conditions we find that they produce insensible effect in three out of the four cases, and in the fourth case, that of girls' refraction, it is more abnormal when the economic conditions are good! We may again assert that home environment as measured by poverty is not the source of defective vision.

Taking the general physical condition and health of the parentage we can find absolutely no relationship between this and the goodness of sight; the first significant figure is for each series in the third place of decimals and this is far beyond the probable errors of the results.

Lastly we turn to the moral condition of the parents. In three out of the four values a better condition exists in the case of those whose parents belong to the immoral category. Looking at this table as a whole we say that any of the home-factors we have dealt with is certainly not largely productive of defective vision. Normal vision is on the whole *slightly* associated with overcrowding, bad economic conditions, and morally defective parentage. Can it be that these bad home conditions keep the children in the streets, and so relatively away from the bad environment and in relatively fresher air? Be this as it may the Edinburgh data show that the intensity of the effect of home influence is not one-tenth that of heredity and what exists, if it be considered appreciable at all, is in the exactly opposite direction to what one would *a priori* have anticipated.

(15) *Influence of Vision on Intelligence.* Thus far we have seen that heredity is apparently the main factor in determining the character of sight. We may conclude the present investigation by enquiring to what extent this heredity factor influences the intelligence or rather the teacher's estimate of the intelligence of children.

The Edinburgh children are classed by their teachers into groups of Excellent, Good, Medium, Dull and Defective Intelligence. Tables† have been formed showing the relation of these categories to keenness of vision and to refractive class. They

* The remarkable irregularity of the excesses and defects in the contingency tables XLIX to LII shows how little stress can be laid on the values of the contingency coefficients found.

† See Tables LXVI—LXIX.

have been reduced by contingency and by fourfold division and the values found are given in Table LXX. It will be seen that Keenness of Vision has slightly more influence than Refractive Class on intelligence. Further, although the relationship is not as large as some writers would lead us to believe, it is quite sensible and no doubt bad sight does lead occasionally to a child being classed as dull, careless or lazy.

It has been shown that the resemblance in intelligence between brothers and sisters is about ·48*. It is interesting to notice how much of this resemblance might possibly be due to defective vision influencing the teacher's judgment, supposing there were no real correlation between defective vision and intelligence. If we assume the inheritance of defective vision to be at least ·4, the contribution would be $\cdot 4 \times \cdot 16 = \cdot 06$, or possibly $\frac{1}{8}$ of the value found for resemblance in intelligence might be due to

TABLE LXVI. *Refraction Class and Intelligence. Boys.*

Intelligence

Refraction Class	Excellent	Good	Medium	Dull	Defective	Totals
Normal	42	174	160	59	9	444
Hypermetropia	6	37	40	17	2	102
Hypermetropic Astigmatism	5	24	23	14	1	67
Mixed Astigmatism	—	6	10	3	1	20
Myopic Astigmatism and Myopia	—	6	8	3	1	18
Totals	53	247	241	96	14	651

TABLE LXVII. *Refraction Class and Intelligence. Girls.*

Intelligence

Refraction Class	Excellent	Good	Medium	Dull	Defective	Totals
Normal	27	131	124	47	11	340
Hypermetropia	4	26	39	12	—	81
Hypermetropic Astigmatism	3	25	32	13	1	74
Mixed Astigmatism	1	10	6	4	1	22
Myopic Astigmatism and Myopia	—	5	7	6	2	20
Totals	35	197	208	82	15	537

* *Biometrika*, Vol. III. p. 155. See also Vol. V. p. 473.

Fourfold Tables.

TABLE LXVI *bis.* *Boys.*

Intelligence

Refraction Class	Excellent, Good	Medium, Dull, Defective	Totals
Normal.........	216	228	444
Ametropic ...	84	123	207
Totals......	300	351	651

TABLE LXVII *bis.* *Girls.*

Intelligence

Refraction Class	Excellent, Good	Medium, Dull, Defective	Totals
Normal.........	158	182	340
Ametropic ...	74	123	197
Totals......	232	305	537

TABLE LXVIII. *Keenness of Vision and Intelligence. Boys.*

Intelligence

Vision	Excellent	Good	Medium	Dull	Defective	Totals
Normal	44	192	168	68	8	480
6/9..	4	27	33	5	3	72
6/12	—	9	11	8	—	28
6/18	4	20	24	14	1	63
6/24 and under......	—	8	8	5	2	23
Totals......	52	256	244	100	14	666

TABLE LXIX. *Keenness of Vision and Intelligence. Girls.*

Intelligence

Vision	Excellent	Good	Medium	Dull	Defective	Totals
Normal	30	145	136	54	8	373
6/9......	3	27	28	13	2	73
6/12	1	12	20	6	—	39
6/18	—	16	25	8	4	53
6/24 and under......	1	6	7	5	1	20
Totals......	35	206	216	86	15	558

Fourfold Tables.

TABLE LXVIII *bis.* *Boys.* TABLE LXIX *bis.* *Girls.*

Vision	Intelligence (Boys): Excellent, Good	Medium, Dull, Defective	Totals	Intelligence (Girls): Excellent, Good	Medium, Dull, Defective	Totals
Normal	236	244	480	175	198	373
6/9 and under...	72	114	186	66	119	185
Totals......	308	358	666	241	317	558

TABLE LXX. *Relation of Intelligence to Refraction and Keenness of Vision.*

Method	Refraction Class		Keenness of Vision		Mean
	Boys	Girls	Boys	Girls	
Contingency	·13	·19	·20	·18	·17
Fourfold Table	·12	·14	·16	·18	·15
Mean......	·13	·16	·18	·18	·16

the resemblance in defective vision. On the other hand the physical source of defective vision is probably not only indirectly related to the teacher's estimate of intelligence but also associated with the actual mental power. Defective vision will often be found coupled with a physical degeneracy, which directly influences the intelligence. Bad sight is seen to be sensibly, but not markedly, correlated with want of intelligence. Until, however, we know that there is no relationship between myopia and actual defective intelligence*, we must not assume that the improvement of the sight would much improve the estimate of intelligence.

Undoubtedly all resemblance in ability between children and parents is ultimately physical, and connected with the acuteness of sensation as well as the facility in mental processes. From this standpoint it is of interest to find that sight probably contributes its quotum to the measure of inheritance of ability.

(16) *General Conclusions.* This paper is admittedly only a *first* study of the eugenic side of vision. No one can recognise its defects more fully than the authors themselves do. These defects obviously arise from a double source. In the first place

* A study of refraction and vision among imbecile and defective children would be of much value from this standpoint.

the specialists who have collected statistics of vision and have the requisite ophthalmological knowledge appear to have little or no statistical training, and hardly realise the nature of those statistical classifications and methods, which alone can lead to definite results. In the second place those who have training in statistical processes and a knowledge of the type of problems which arise in other branches of eugenic enquiry, are liable to slip in dealing with such specialised material as the present.

The topics, which the student of eugenics must ever keep before him, are:

(i) The influence of breeding on the good or bad grade of each human characteristic.

(ii) The intensity of the effect produced by nurture on the same characteristics.

In the case of the physical properties of the eye he needs (i) material showing for a random sample of the population the influence of parentage and ancestry on the eyes of the offspring. He further requires (ii) to know, as in the case of all human characters, the law of average growth, and (iii) to measure the relative intensity of the influence of home life, school life, and adult occupation on the characters of the eye.

There cannot be a doubt that the anthropometric school laboratory, which takes ophthalmological observations of the eyes of the same boys and girls for the whole period of their school life, will obtain much more valuable scientific material, than the laboratory which still further adds to the endless and mostly unutilised data for height, weight and chest measurements. Further, something of the same kind ought to be done for adults, commencing, say, with the undergraduate population and passing to sample occupations*. The urgent point at present is to obtain a standard population which is not ophthalmologically selected. The first object must be to measure for anthropometric purposes the eye-sight of each child, and for these purposes we ought to know the refraction and the astigmatism to at least $\frac{1}{4}$ dioptre, and replace the "keenness of vision" test by a more scientific continuous system than the type letters with their discrete sizes and consequent lumpings of frequency†. In a fixed anthropometric laboratory, it ought to be easy to alter continuously the size of the type letter, and thus obtain a continuous system of readings. This is not a criticism of the ophthalmologist's methods, but merely a statement of the fact that for the study of heredity it is not satisfactory to group 75 °/₀ of brothers together as 6/6. Within this group lie many grades of keenness of vision, which undoubtedly we shall find are individually inherited. The results obtained by such a school laboratory—until centres of measurement are multiplied—will not be as numerous as those which deal by aid of a coarse sieve with tens of thousands of children but for our present purposes they will be of higher value. Again such splendid work as that of the Edinburgh Charity Organisation Society which follows

* Many large firms employ hundreds of workpeople, whose physical fitness, including goodness of vision, is an asset of as great value as the efficiency of the machinery. A careful annual ophthalmological inspection would very soon repay its cost by enabling us not only to measure occupational influence, but to prescribe occupational hygiene.

† The evil effect of this is manifest in Tables XXXII—XXXIII.

each child into its home, if it must perforce deal with hundreds instead of thousands, is essential if we are to determine the influence of home environment. The like problem in adult life may be more difficult, and at present we may have to trust largely to ophthalmological selections like those of Steiger, but the urgency is as great as the difficulty and we insist on the random sample of the general adult population as the ultimate goal. No argument as to heredity from the ophthalmologist's sample is valid without allowance, often wide allowance, for this selection. When we turn to the influence of school environment, we long in vain to find a few hundred children of both sexes brought up without school and without reading as a standard population. Uncivilised races are probably too different from civilised races in other forms of environment than merely absence of school life, to be safe guides, although a thorough ophthalmological survey of one or two uncivilised races would undoubtedly be of value. Perhaps the best we can do at present is to compare town with country schools, schools having few with schools having many children, schools optically well with schools ill arranged, and the sight of those who remain students till adult life with the sight of those who go into rural occupations at 13 to 15. All these things will aid in throwing light on the influence of environment if they do not completely determine it.

As far as the admittedly slender data of this first study reach, there is:

(i) No evidence whatever that overcrowded, poverty stricken homes, or physically ill-conditioned, or immoral parentages are *markedly* detrimental to the children's eye-sight.

(ii) No sufficient or definite evidence that school environment has a deleterious effect on the eye-sight of children. Undoubtedly considerable changes of vision take place during school years, marked first by a decrease in the hypermetropic classes and an increase in the emmetropic class. This is followed between 10 and 14 by a decrease in the emmetropic class and an increase in the hypermetropic, astigmatic and myopic classes; the balance being still in favour of emmetropia when school is left. Is the first a growth law and the second an environmental effect, or are both but phases of one law of growth—a passage from hypermetropia to emmetropia and myopia of the eyes of "unstable stocks"? It is suggested that the latter is the truth, because so many hypermetropic individuals have myopic siblings, and in 60 °/。 of cases the hypermetropic sibling is the younger. This is a suggestion; it is far from being definitely proved, but it serves to indicate that the charge against the school from the standpoint of vision has yet to be firmly established.

(iii) Ample evidence that refraction and keenness of vision are inherited characters, and that the degree of correlation between the eye-sight of pairs of relatives is of a wholly different order to the correlation of eye-sight with home environment.

(iv) Sufficient evidence to show that intelligence as judged by the teacher is correlated with vision in a moderate manner (·16). There is not enough evidence to prove that if the source of poor vision were removed the intelligence would reach a higher stage. Defective physique including defective powers of sensation

are we know closely correlated with defective mentality, they are both signs of an ultimate physical degeneracy. In many cases, no doubt, helping the vision will aid the intelligence, but we cannot suppose that poor vision is the source of all the poor intelligence we find associated with it.

This is the first eugenic study which has endeavoured to compare the inheritance and the environment factors. We anticipated finding them to be far more comparable in magnitude. As far as the material developed in this memoir goes, it points, if not overwhelmingly at least strongly, to the moral: Pay attention to breeding, and the environmental element will not upset your projects. Improve to the utmost your environment, and breeding will lay low your schemes.

The first thing is good stock, and the second thing is good stock, and the third thing is good stock, and when you have paid attention to these three things, fit environment will keep your material in good condition. No environmental or educational grindstone is of service, unless the tool to be ground is of genuine steel—of tough race and tempered stock.

To bring home this fact in each department of human physique and mentality seems to be the urgent social problem of to-day.

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ON THE RELATIONSHIP OF CONDITION OF THE TEETH IN CHILDREN TO FACTORS OF HEALTH AND HOME ENVIRONMENT

BY
E. C. RHODES, B.A., [illegible]
[illegible]

WITH FOUR DIAGRAMS IN TEXT

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ON THE RELATIONSHIP OF THE CONDITION OF THE TEETH IN CHILDREN TO FACTORS OF HEALTH AND HOME ENVIRONMENT

ON THE RELATIONSHIP OF THE CONDITION OF THE TEETH IN CHILDREN TO FACTORS OF HEALTH AND HOME ENVIRONMENT

BY

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PREFATORY NOTE.

THE existence of various theories as to the sources of defective teeth in children—many supported by little or no statistical demonstration—suggested to the members of the Galton Laboratory the great importance of a fuller investigation of the relations between the condition of teeth in children and (i) their general health, (ii) their home environment, and (iii) the goodness or badness of the teeth of their parents.

It would seem at first sight that something of value with regard to (i) might be learnt from the ordinary schedules of school medical inspection. Such schedules, however, contain very little information with regard to (ii); indeed, only such information as can be obtained indirectly from the employment or status of the father, and the cleanliness of body and clothes of the children themselves. With regard to (iii) nothing, of course, could be ascertained in this way. When, however, we came to study the matter, great difficulties arose even with regard to (i); the records of the teeth are only a few of many entries which the medical officers have to make in a very hurried manner owing to the demands on their time; there is, further, very little attempt to standardise the various medical inspectors who worked in approximately the same areas, and we were rapidly convinced that, until such standardisation takes place, differences, not only in teeth, but in various factors of children's health, will be attributed to environment when they are really due to the personal equation of the assistant school medical officers.

With the object, therefore, of obtaining fuller and more reliable data, not only as to the teeth, but as to eyes, clothing, and other matters, the Galton Laboratory obtained permission for two medical men, its own nominees, to assist in the medical inspection of a large school. The data thus obtained are being reduced at the present time. While these school investigations were in progress "visitors" selected by the

Laboratory called at the homes of the children and were able to obtain fairly comprehensive details of the home environment. Thus some material was collected, if not as complete as we could desire, with regard to both (i) and (ii).

We next turned our attention to (iii), and the most suitable locus for such investigations appeared to be a dental clinic to which mothers were in the habit of bringing their children for dental advice, and where it would be possible to some extent to observe both child and parent. Unfortunately the war intervened before these investigations were completed, but a considerable number of schedules were filled in, and it is hoped that some day further material may be obtained from the same or another clinic.

While these investigations were in progress we came across the Report to the Blankshire County Council of the School Medical Officer for 1912. As it contained what were clearly more ample dental records than are usually made in school medical inspections, we asked permission to examine the original schedules, and it is this material which is analysed in the present memoir. The purpose of this first paper on the condition of the teeth in children will be adequately fulfilled if it demonstrates that there is a wide field in which there is room for valuable co-operation between an institute like ours established for research purposes, and a municipal executive having to make for practical ends a very rapid survey of its child population and having little if any leisure for research.

There are many urgent practical problems which could be adequately solved by a study of the child population of this country, but they can only be solved by the leisurely laboratory method of observation, by standardised judgments and an efficient training in modern statistical methods. At present the observations are too rapid to be of great scientific value, the judgments are personal opinions rather than real measures of fact, and the statistical methods of school officers' reports rarely indicate a knowledge extending beyond the elementary rules of arithmetic. These results are not due to any fault of the medical officers themselves, but to the inadequate system under which they are trained for their work, and to the speed under which they are compelled to form their record.

K. P.

CONTENTS.

CONTENTS

ON THE RELATIONSHIP OF THE CONDITION OF THE TEETH IN CHILDREN TO FACTORS OF HEALTH AND HOME ENVIRONMENT.

THE data analysed in this paper were collected by the School Medical Officers of the Blankshire County Council, in 1911, and for permission to use them I must thank heartily the Senior School Medical Inspector. In addition I have found much helpful information in the Annual Reports prepared by him which have been kindly sent to the Galton Laboratory. I am greatly indebted to Miss E. A. Jones for the saving of much labour in the preparation of the Tables used. Miss E. M. Elderton has allowed me to make use of work done some years ago on the correlation between Teeth and Weight, and has throughout this paper helped me with much friendly advice. Professor Karl Pearson has supervised the work of the whole paper, and I wish to thank him for his many helpful suggestions and kind encouragement during the past months. My thanks are also due to Miss L. de M. Carey and Miss I. McLearn for the diagrams prepared by them to illustrate the work in the following pages.

I. INTRODUCTION: THE DATA.

For the purposes of School Medical Inspection the whole county was divided into five districts, there being five Medical Inspectors, each of whom took one district and examined all the children in that area. In this paper we shall hereafter refer to the five doctors as D 1, D 2, D 3, D 4, D 5, and their allocation to the various regions was as follows:—

Mid-West.	Mid-East.	North.	South-East.	South-West.
D 1	D 5	D 3	D 4	D 2

From the first annual report of the School Medical Inspector for 1908, we find that these areas can roughly be classified as follows: The Middle region is practically entirely agricultural, the North is a decidedly hilly country, where the people are partly occupied with mining and partly with sheep farming in the moorlands, the South Western area and the South Eastern area contain the coal mines and iron foundries for which the county is noted, and most of the larger towns lie in the South Western area. All the doctors, however, had a mixed population of town

and country children to deal with, and these two populations are differentiated with regard to age, since the leaving ages of children in urban schools and rural schools are not exactly the same.

The children inspected were those of ages 4-5 ; 8-9 ; 12-14 years. And as the chief purpose of this paper is to find any connection between the state of the teeth and other characters dealt with in the medical inspection, those children in the last age group only were considered, for by the time they had attained the age of 12 years it was assumed that they would have no longer any milk teeth.* Consequently our data is immediately divided into two groups, one dealing with children attending urban schools where they are examined after they attain 13 years, and the other dealing with children attending rural schools where they are examined after they reach the age of 12 years. In the former group, as the inspection is spread over the whole year, the ages of the children inspected range from 13 to 14 years and the mean age is 13½ years : similarly, in the latter group the mean age is 13 years. Henceforth we shall refer to these two groups of children as B 13½, G 13½ ; B 13, G 13, the abbreviations B and G standing for boys and girls respectively, and we shall be understood to mean that any 13½ group is from an urban school population and any 13 group from a rural school population.

As D 1 had very small 13½ groups, the totals being only in the region of 10, these have been entirely neglected in this work.

Primarily the data were examined with special reference to the condition of the teeth, but as it was found that the data could be treated from other points of view, this was done and the results are given here.

II. GROUPING THE DATA.

The total numbers of the children examined by each doctor and their distribution in the respective age and sex groups are shown in the accompanying table, together with the geographical and economic distinctions.

	B 13.	G 13.	B 13½.	G 13½.	Total.		
D 1	143	190	16	10	359	Mid-west	Rural
D 2	150	179	252	280	861	South-west	Town
D 3	257	239	221	248	965	North	Mixed
D 4	295	313	263	243	1114	South-east	Mixed
D 5	360	337	241	212	1150	Mid-east	Rural
Total .	1205	1258	993	993	4449		

A consideration of the numbers of children examined by each doctor, set out in the above table, shows how desirable it is that we should be able to group all the doctors together and work with four sets of data, one for each of the sex and age

* Actually some children were found with carious milk teeth.

groups B 13, G 13, B 13½, G 13½, for with totals of 1205, 1258, 993, 993, we should get much smaller probable errors of our means, standard divisions and correlation coefficients than with the individual totals of each doctor. Our first object, therefore, must be to test the distributions given by each doctor for each group of children, in order to discover whether the data can be grouped together and if not, to find which doctors we may combine. In order to obviate any possible personal equation affecting the results, we make our test on the distribution of the children examined by each doctor for weight and height, because these measurements should be invariable from one district to another and the records were taken by persons other than the doctors, so that there is no question of personal equation entering into the distributions.

As we wish to find out if the various districts have the same type of population and, therefore, may be grouped together, we start by testing whether two given distributions are random samples of the same population on the 8-9 year groups, because the total numbers of children in these groups are in the region of 1000, a much larger number than those involved in the later groups of 13½ and 13 which we are to consider in these pages. If we find that as a result of this test on 8-9 groups we can or cannot group together two districts as being similar samples from the same population, we are justified in accepting or rejecting such combinations for our groups of older children.

We have, then, these results for the B 8-9 distributions.

B 8-9. Probability of the distributions being random samples from the same population, all possible pairs being taken.

	D 1, D 2.	D 1, D 3.	D 1, D 4.	D 1, D 5.	D 2, D 3.	D 2, D 4.	D 2, D 5.	D 3, D 4.	D 3, D 5.	D 4, D 5.
Height distributions .	·0000	·12	·005	·64	·0000	·01	·0000	·40	·16	·0005
Weight distributions .	·0000	·15	·02	·42	·0000	·081	·0000	·09	·68	·005

When we consider this table of chances, looking first at those obtained for height distributions, we are inclined to accept as possible combinations the distributions of D 1 and D 5, D 3 and D 4, and D 3 and D 5, and to reject all the other combinations as not being probable. Turning now to the lower row of probabilities, those obtained from the weight distributions, we see that according to these figures the combination of D 3 and D 5 together is now more possible, and that the probability of D 3 and D 4 being samples of the same population is much reduced, being ·09, while those obtained from comparing the distributions of D 4 and D 1, D 4 and D 2, and D 4 and D 5 are increased. We will deal with these two points in turn. First, the question of D 3 and D 5 being a possible combination—we see that D 1 and D 5 divide between them the middle region of the county, which is described as mainly agricultural, and that apparently D 1 has that district in which there are very few urban schools, because the numbers of children of the 13½

groups returned for this doctor being only twenty-six altogether, while D 5 examines more equal numbers of rural and urban children. On the other hand, the region inspected by D 3 in the North has a mixed population similar to that examined by D 5. We must reject the possibility of all three doctors being combined together owing to the low values obtained when D 1 and D 3 are compared. From the geographical distribution we should anticipate that these three groups would show such possibilities, but remembering that the middle region is mainly flat and agricultural, whereas the northern region is more hilly and the inhabitants are occupied in mining and sheep farming—we are inclined to combine D 1 and D 5 and reject the possibility of combining D 3 and D 5. By this arrangement, the rural schools of the former group would be all combined together, and they represent a farming community. Also the 13½ groups of this combination will be entirely those of D 5 and will represent an urban population of small towns in the pleasant central area of Blankshire. Whereas if we combined D 3 and D 5 we should have a rural population, some of which were from the sheep farms and the hills, and the rest from the more general farms of the middle region, and an urban population, composed of the mining towns of the North and the more rural small towns of the middle region. In order to test this arrangement a comparison was made of the distributions of weight returned by D 3 and D 5 for B 4-5 which gave a probability of only ·02, so we finally rejected this combination and decided to combine D 1 and D 5.

Secondly, with regard to the curious lack of agreement between the probabilities in the above table in cases where D 4 is concerned, we made a further test on the distributions of B 4-5 with these results:—

	D 4, D 3.	D 4, D 2.
Height distributions	·35	·001
Weight distributions	·14	·21

Again we have the same thing occurring—that D 3, D 4 is a possible combination from a comparison of the distributions of height, but that the probability is less when we consider the weight distributions, and further that the probability of D 4 and D 2 being combined is for weight but not for height a possibility. The same was found when we compared the distributions of G 8-9 with these results:—

	D 4, D 3.	D 4, D 2.
Height distributions	·19	·0001
Weight distributions	·014	·16

When we consider what may have given rise to this anomaly, the possibility arises that the weights given for the D 4 district may be in error by a constant amount owing to a defect in the weighing machine used, for this machine was carried about from school to school. The mean weights of the children in D 3's area are greater than those in D 2's area, and if the weights returned by D 4 were all less than they actually should be by a small amount, then we can see that the

probability of D 3, D 4 being a possible combination would be decreased, while the probability of the D 4, D 2 combination would be increased.

The mean weights and heights for the different groups in the D 3 and D 4 regions were found, and are shown below with the differences between the corresponding groups.

We have the following mean values for the various age and sex groups :—

	Mean Heights (Inches).		Difference (3-4).		Mean Weights (Lbs.).		Difference (3-4).	
	D 3.	D 4.			D 3.	D 4.		
B 4-5	42·052	41·915	·14 ± ·06	·21 ± ·045	41·046	40·447	0·60 ± ·15	·8 ± ·11
G 4-5	41·994	41·662	·33 ± ·07		40·264	39·238	1·03 ± ·15	
B 8-9	48·237	47·916	·32 ± ·09	·20 ± ·06	53·540	52·500	1·04 ± ·25	·7 ± ·18
G 8-9	47·876	47·803	·07 ± ·09		51·341	51·083	0·26 ± ·25	
B 13	55·664	55·498	·17 ± ·17	·32 ± 0·9	75·635	74·025	1·61 ± ·60	1·9 ± ·33
G 13	56·406	56·307	·10 ± ·18		76·882	76·639	0·24 ± ·68	
B 13½	56·384	55·795	·58 ± ·18		78·812	75·293	3·52 ± ·64	
G 13½	57·061	56·612	·48 ± ·18		81·765	79·099	2·67 ± ·80	

We see that whereas the differences between the means of the groups examined by D 3 and D 4 are barely significant when compared with the probable errors in the height distributions, yet these differences are significant when we consider the weight distributions and are persistently of the same sign.

Consequently we are led to the following proposition :—

Given two distributions, which are samples from the same population—in one distribution the scale has been altered by a constant amount, how can we find the error thus introduced ?

Consider the two populations given :—

$$y_0\, y_1\, y_2 \;\;.\;\;\;.\;\;\;.\;\; y_n \quad \text{total N}$$
$$z_0\, z_1\, z_2 \;\;.\;\;\;.\;\;\;.\;\; z_n \quad \text{total N}'.$$

We are to alter the second distribution by altering the scale by a constant amount and get a new distribution.

$$z_0'\, z_1'\, z_2' \;\;.\;\;\;.\;\;\;.\;\; z_n' \quad \text{total N}'.$$

z_0'	z_1'	z_2'		z_n'	z'_{n+1}
z_0	z_1	z_2		z_n	

If we assume that the scale is too low by an amount m units where m is < 1 then we have these values for $z_0'\, z_1'$, etc., in terms of $z_0\, z_1$, etc.

$$z_0' = z_0 - m\frac{(2z_0 + 5z_1 - z_2)}{6} + \frac{m^2}{2}(z_1 - z_0)$$

$$z_1' = z_1 - \frac{m}{2}(z_2 - z_0) + \frac{m^2}{2}(z_2 - 2z_1 + z_0)$$

$$z_2' = z_2 - \frac{m}{2}(z_3 - z_1) + \frac{m^2}{2}(z_3 - 2z_2 + z_1)$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$

$$z'_{n-1} = z_{n-1} - \frac{m}{2}(z_n - z_{n-2}) + \frac{m^2}{2}(z_n - 2z_{n-1} + z_{n-2})$$

$$z'_n = z_n - \frac{m}{2}(3z_n - 4z_{n-1} + z_{n-2}) + \frac{m^2}{2}(z_n - 2z_{n-1} + z_{n-2})$$

$$z'_{n+1} = \frac{m}{6}(11z_n - 7z_{n-1} + 2z_{n-2}) - \frac{m^2}{2}(2z_n - 3z_{n-1} + z_{n-2}).$$

where we assume that m^3 is sufficiently small to be neglected, and that the frequency curve of the distribution can be represented with sufficient accuracy as the combination of a series of parabolas.

Now this distribution $z_0'\, z_1' \ldots z_n'\, z'_{n+1}$ must be comparable with $y_0\, y_1 \ldots y_n$ and these two distributions should be random samples from the same population. The usual procedure is to find

$$\sum_0^{n+1} \frac{\left(\frac{y_r}{N} - \frac{z_r'}{N'}\right)^2}{y_r + z_r'} \,.\, N \,.\, N' = \chi^2 \text{ (say).}$$

For a given number of classes into which the distributions are arranged, the smaller this function is, the greater is the probability that instead of having the distribution given by the y's we had obtained the distribution given by the z''s. Consequently we require to choose m so that the above is a minimum.

Now $$\chi^2 = \sum_0^{n+1} \frac{(N'y_r - Nz_r')^2}{NN'(y_r + z_r')} = \sum_0^{n+1} \frac{[N'y_r - N(z_r - m\alpha_r + m^2\beta_r)]^2}{NN'(y_r + z_r - m\alpha_r + m^2\beta_r)}$$

where $\alpha_r \,.\, \beta_r$ are the coefficients of m and m^2 in the expressions above for $z_0'\, z_1' \ldots$

i.e. $$\alpha_r = \tfrac{1}{2}(z_{r+1} - z_{r-1}) \text{ for } r = 1, 2 \ldots n - 1$$

$$\alpha_0 = \frac{2z_0 + 5z_1 - z_2}{6}$$

$$\alpha_n = \frac{3z_n - 4z_{n-1} + z_{n-2}}{2}$$

$$\alpha_{n+1} = -\frac{11z_n - 7z_{n-1} + 2z_{n-2}}{6}, \text{ etc.}$$

we can put χ^2 in the form

$$\sum_0^{n+1} \frac{\{(N' + N)y_r - N(y_r + z_r - m\alpha_r + m^2\beta_r)\}^2}{NN'(y_r + z_r - m\alpha_r + m^2\beta_r)}$$

i.e. $$\sum_0^{n+1}\left[\frac{N}{N'}(y_r + z_r - m\alpha_r + m^2\beta_r) - 2\frac{N + N'}{N'}y_r + \frac{(N + N')^2 y_r^2}{NN'(y_r + z_r - m\alpha_r + m^2\beta_r)}\right].$$

Now this is to be a minimum, and we have the condition, found by differentiating with respect to m.

$$\sum_0^{n+1}\left\{\frac{N}{N'}(-a_r + 2m\beta_r) + \frac{(N+N')^2 y_r^2(a_r - 2m\beta_r)}{NN'(y_r + z_r - ma_r + m\beta_r)^2}\right\} = 0$$

i.e. we have $$\sum_0^{n+1}\frac{y_r^2(a_r - 2m\beta_r)}{(y_r + z_r - ma_r + m^2\beta_r)^2} = \sum_0^{n+1}\frac{N^2}{(N+N')^2}(a_r - 2m\beta_r)$$

$$= \frac{N^2}{N+N'^2}\frac{1}{6}\left\{(z_n - 2z_{n-1} + z_{n-2}) - (z_2 - 2z_1 + z)\right\},\ \text{for } \sum_0^{n+1}\beta_r = 0.$$

We have this equation from which to find m, and the approximate values of m obtained from the weight distributions given by D 3 and D 4 for B 8-9, B 4-5, and G 8-9—when we alter the scale of D 4's distributions, are:—

B 8-9	$m = \cdot 4$
B 4-5	$m = \cdot 2$
G 8-9	$m = \cdot 2$

As our working unit is 3 lbs. this means that roughly, the D 4 distributions are 0·6 lbs. different in scale from those of D 3. That is to say the machine used in the D 4 district is weighing ½ lb. too low. If then we take this as an approximation to the actual facts, we find that we get new distributions for the cases considered which when compared with D 3 give the following probabilities of the two distributions being samples from the same population, which we can compare with those obtained originally with the D 3, D 4 distributions as given:—

	P.		P.
B 8-9	·26	B 8-9	·09
B 4-5	·47	B 4-5	·14
G 8-9	·05	G 8-9	·014

If we now compare these new D 4 distributions with the given D 2 distributions we have these values for the probability which we can compare with those obtained before:—

	New P.	Old P.
B 8-9	·04	·081
B 4-5	·06	·21
G 8-9	·12	·16

We see then that this assumption of wrong scale in the D 4 weight distributions, gives us results which conform more closely with the results obtained from the height distributions than originally was the case. The only doubtful case is that of G 8-9, where the improvement resultant upon the change in the scale is not nearly so great as in the other two cases. We are led then to the combination of D 3 and D 4 and to reject all other possible combinations. We are the more inclined to adopt this grouping as, although the districts are geographically at opposite ends of the county, yet the type of population seems to be somewhat the same in both of them, containing both urban and rural elements. There is no justification, as we have seen, for combining D 2 with any of the other doctors.

We shall attempt, therefore, in this work to combine the data given by D 1 and D 5 and that given by D 3 and D 4. We consider that although we have made our tests of sampling on data other than that actually examined later in the paper, we are justified in this step, in spite of the fact that an examination of the distributions of children of 13 and 13½ would show that practically all the doctors could be grouped together owing to the smaller frequencies involved. As an illustration of this we have the table below.

When we examine the height and weight distributions for B 13, we have the following values of the probability of the possible combinations being random samples from the same population:—

B 13.

	D 1, D 2.	D 1, D 3.	D 1, D 4.	D 1, D 5.	D 2, D 3.	D 2, D 4.	D 2, D 5.	D 3, D 4.	D 3, D 5.	D 4, D 5.
Height . .	·36	·32	·60	·45	·91	·96	·64	·89	·34	·11
Weight . .	·68	·68	·46	·53	·73	·46	·44	·55	·71	·29

We see from such an examination that we could take any combination of the doctors and consider that the distributions given by them were all random samples from the same population.

We must point out that we have made the tests above on the weight and height distributions in order to find out which districts have sensibly the same type of population, but that when we come to the consideration of the distributions of the various districts for teeth, nutrition, etc., we must examine the distributions given by the different doctors for any possible differences due to different methods adopted by the doctors in their diagnoses.

III. TEETH DISTRIBUTIONS.

(i) Considering now the teeth distributions given by the various doctors which represent the numbers of children in the various groups with perfect teeth and those having one, two, three, etc., teeth carious, we note immediately that all the doctors with one exception, D 4, finish up their tale of bad teeth with a group described as "several," meaning several teeth carious, but unfortunately all the doctors do not, mean the same thing by "several" and individual doctors vary the meaning of "several" in the examination of the different age and sex groups. In consequence, we are faced with the necessity for departing from the quantitative grouping of 0, 1, 2, . . . teeth carious, to such indefinite groupings as Perfect, Moderate (1 and 2 carious), and Bad (3 and more carious); or even into two classes Good (including Perfect and 1 carious); and Bad, including the rest.

The following table shows how the different doctors distribute the teeth in the various groups of children.

	Pf.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Several.	Total.
D 1—														
B 13	24	26	34	24	15	5	4	2					9	143
G 13	33	40	58	17	22	9	3						8	190
B 13½	6	3	3	2		1							1	16
G 13½	0	1	7	1	1									10
D 2—														
B 13	15	26	49	20	19	8	6		2				5	150
G 13	45	27	43	28	15	5	1	4	2				9	179
B 13½	76	42	53	27	12	14	2	2					24	252
G 13½	76	50	73	36	18	8	6	1					12	280
D 3—														
B 13	60	37	95	36	18	1							10	257
G 13	66	36	80	25	24								8	239
B 13½	49	28	84	27	19								14	221
G 13½	58	49	64	25	25								27	248
D 4—														
B 13	60	77	80	36	26	11	3	1	1					295
G 13	65	66	87	42	28	15	8	1	1					313
B 13½	55	64	65	45	14	12	6	1	1					263
G 13½	45	50	68	43	19	9	6	1			1		1	243
D 5—														
B 13	64	36	25	7		1						1	226	360
G 13	61	38	34	7	5	1							191	337
B 13½	36	21	16	3									165	241
G 13½	25	19	22	6	1								139	212

From this table we have then these possible meanings of the group " several " as interpreted by the five doctors:—

Doctor.	" Several."
D 1	more than 7.
D 2	more than 8.
D 3	more than 5.
D 4	more than 10.
D 5	more than 5.

This divergence of opinion amongst the several doctors drive us from the numerical grouping of the distribution to the grouping in categories—good, bad, etc.

Further examination of this table shows us other divergencies between the distributions. First, the sizes of the " several " groups in D 5's distributions are out of all proportion to the sizes of the " several " groups of the other doctors. Secondly, the groupings of the various doctors in the first three categories (Pf, 1, 2) are different as is seen in the accompanying table, and we are forced to the conclusion that the doctors have all different standards upon which they base their judgments

of bad teeth ; so that although our material allows us to combine D 3, D 4 ; D 1, D 5

	Pf.	1.	2.
D 1	Increasing to a maximum.		
D 2	Maximum.	Minimum.	Maximum.
D 3	Maximum.	Minimum.	Maximum.
D 4	Increasing to a maximum.		
D 5	Maximum, then decreasing.		

we are unable to do this for any discussion of teeth on account of the divergences in the doctors' distributions of teeth.

(ii) We can see this still further when we analyse the teeth distributions and find the means and standard deviations. To do this we must proceed as follows :—

Being obliged to group the teeth in non-numerical divisions, we chose three: Pf : 1, 2 : Rest, i.e. taking the perfect group as one of our three groups, combining 1 and 2 groups into our new middle group, and combining all the other groups into one end group. From the distribution as given by these three groups we can find the mean and standard deviation of each distribution, for the width of the middle group in teeth units is 2, and we can express this from Sheppard's Tables in terms of the σ of the distributions, and having found σ, we can find the distance of the mean from the division line between the first group (Pf) and the middle group (1, 2).

We have the following results :—

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 1	1·73549	1·60204	1·35480	1·38164	—	—	—	—
D 2	1·65369	1·22711	1·30110	3·08976	1·03604	2·07329	1·02829	1·71227
D 3	1·09486	1·43750	0·91406	1·55263	1·10909	1·47044	1·22293	1·64562
D 4	1·19312	1·41763	1·18594	1·48907	1·22148	1·50068	1·37838	1·51230
D 5	3·38860	3·69740	2·79728	3·10795	3·84057	3·60705	3·47605	2·95085

and make the following observations on the above table :—

(*a*) We have assumed that the distributions are normal in each case in order to get the means and standard deviations (S.D.'s). We return to this point later.

(*b*) We have not included in the above the few cases examined by D 1 of B 13½ and G 13½.

(*c*) Of the pairs of doctors which may be taken together D 3 and D 4 have means and standard deviations which are not very different. Roughly the probable error of the means given by D 3 and D 4 is ± ·06, and of the standard deviations ± ·04, but the means and standard deviations of D 1 and D 5 are very different. The probable errors of the means of D 5 are roughly ± ·13 and of D 1 ± ·09.

(*d*) The means and standard deviations of D 5 are so widely different from the others that D 5 must have had an entirely different method of teeth examination from the other doctors. When we examine this point further, we find that in the Annual Report for 1908 on "special" cases, i.e. those cases examined by the doctors which are not in the routine years and which are presented by the teachers or picked out by the doctor after the routine inspection has taken place, there is the following paragraph (p. 25); "D 5's 'specials' were more numerous proportionately than those of the other inspectors. This was owing to the fact that D 5's schools were nearly all small country schools with few children. There was, therefore, plenty of time after examining the routine cases, to go round the classes and pick out the 'specials' for herself." This inclines one to the view that, if D 5 had sufficient time after the routine inspection to examine a great number of extra cases, that she had time during the routine inspection to examine the mouth carefully and report on it more fully than the other doctors, consequently presenting distributions which give the average child twice or thrice as many bad teeth as the other doctors. Later, when we attempt to compare the doctors, we shall therefore take D 5 as the standard and find the differences between this doctor and the others.

Although we should be justified *a priori* in combining certain of the doctors and thus have larger frequencies to deal with, since the children examined by these doctors are sensibly of the same type as judged by weight and height, yet these combinations are impossible in dealing with carious teeth owing to the different distributions of teeth given by the individual doctors. Consequently we lose the great advantage of dealing with a large number of cases, and in any discussion of teeth we must deal with several sets of data each having total frequencies in the region 200-300. In correlating teeth with other characters we take each doctor's data separately and find 18 correlation coefficients or ratios each having a large probable error. Having obtained these we can obtain a weighted mean from them and thus get some measure of correlation between various characters for the whole county. The results obtained would have more weight owing to the smaller probable errors involved when larger frequencies are under consideration, if the doctors had had a common standard of judgment of various characters, and we had been able to put together at least some of the data which they obtained.

(iii) We return now to the question of the teeth distributions being Gaussian or normal, which has been assumed to be the case when we found the means and standard deviations above. Actually an examination into the distribution given by D 4 for B 13, which does not contain a "several" category, shows us that this particular distribution is not normal, but on the contrary is decidedly skew, being best fitted by a Type I. Pearson Curve of limited range. The equation to which is

$$y = 86{\cdot}389\left(1 - \frac{x}{15{\cdot}127}\right)^{11{\cdot}819}\left(1 + \frac{x}{1{\cdot}607}\right)^{1{\cdot}256}.$$

This curve is shown in the diagram, together with the given distribution in the form of a histogram.

The theoretical frequencies were obtained from this curve and the theoretical

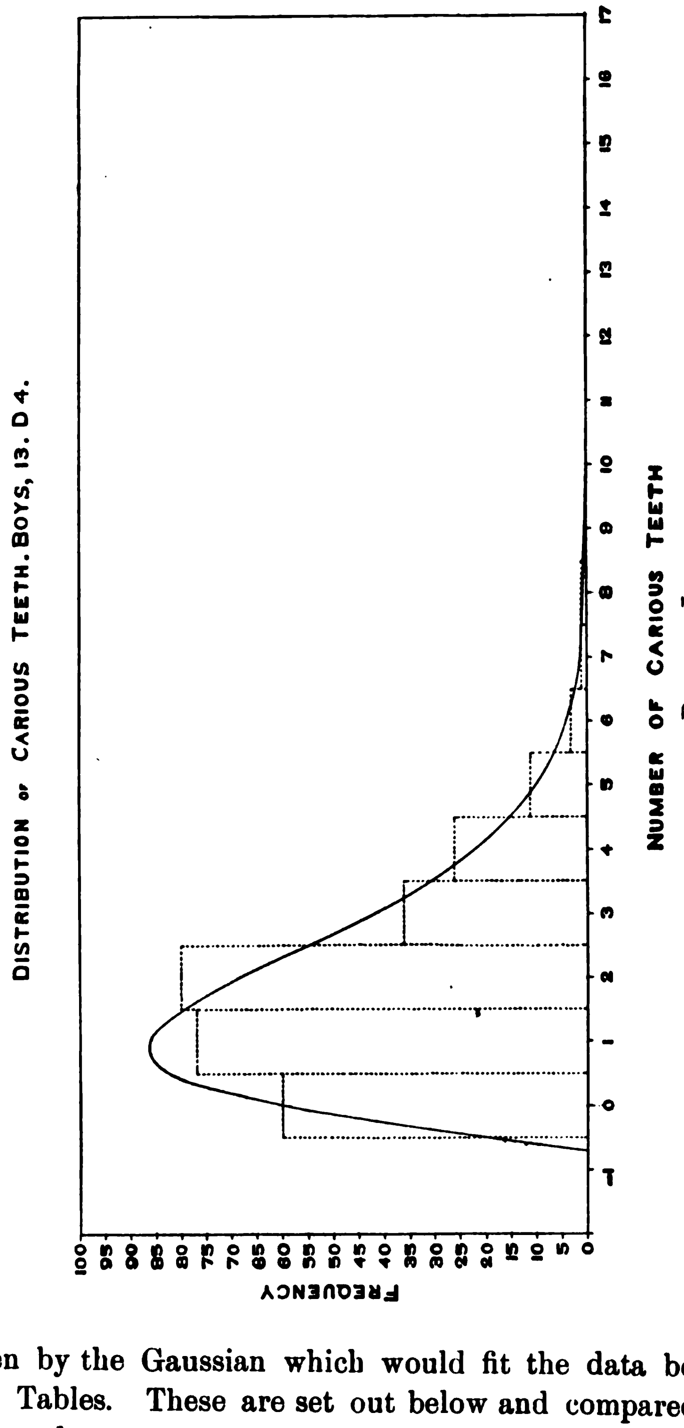

DIAGRAM I.

frequencies given by the Gaussian which would fit the data best were obtained from Sheppard's Tables. These are set out below and compared with the actual frequencies observed.

No. of Carious Teeth.	– 3.	– 2.	– 1.	Pf.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Theoretical (Skew)	—	—	—	61·1	84·0	67·5	42·6	22·7	10·2	4·3	1·5	1·1	295
Observed . .	—	—	—	60	77	80	36	26	11	3	1	1	295
Gaussian . .	0·5	3·3	14·0	38·2	67·4	77·0	56·9	27·3	8·5	1·7	0·2	0·0	295

It will be seen that the skew curve shows more agreement with the observed distribution than the Gaussian, and the result of goodness of fit tests made to compare these, emphasises this, for we obtain probabilities of ·95 when comparing the skew with the observed and ·003 for the other case, and we see that the Gaussian does not fit well the observed data.

We should hardly anticipate for boys aged 13 years, whose teeth are new and therefore probably less carious than the teeth of older boys, that the distribution would be normal. We should anticipate that the distribution would be more normal at a later age. Owing to the fact that the other doctors introduce the indefinite term "several" into their distribution of teeth, we can only consider the teeth distributions in indefinite groups and work out means, standard deviations, and later correlation coefficients, using the methods which would apply were the distributions actually Gaussian. We fully recognise, however, the assumption made.

(iv) We now turn to the association between carious teeth and the weight of the child.

We first form a table for each of the age and sex groups for each doctor, making 18 in all, having the teeth in two groups Good and Bad, the Good group consisting of those given by the doctors as Perfect and 1 tooth carious, and the Bad group consisting of the remainder. The weights are distributed into several groups, each group having a range of 3 lbs. such a group being 52⅞-55⅞ lbs., the mean of this group being at 54⅜ lbs. We take the limits of each group at ⅛ lb. intervals because the actual weights were taken to the nearest ¼ lb. and such grouping obviates any difficulties which might arise as to the frequency of a certain weight falling partly into one group and partly into another. If we had taken our limits from 53-56 lbs., in the particular instance above, this might have occurred.

The "biserial r" method was used and we obtained the correlation coefficients (see next page).

We note that these correlation coefficients are all positive in the case of boys, but that they are either not significant or are doubtful; that in the case of girls they are positive and negative, only two being sufficiently large to be just significant. We see then that there is practically no correlation between teeth and weight in any of the 18 cases considered above, and the weighted mean of all these small correlation coefficients is itself less than three times its probable error, so that we may say that the Blankshire data, considered as a whole, shows no correlation which

is significant between teeth and weight for school children of 12 to 14 years; and regarding weight as some guide to health we may assert that the data examined shows no correlation of any importance between the state of the teeth and the health of the child.

TABLE OF CORRELATION COEFFICIENTS BETWEEN TEETH AND WEIGHT.

(+ sign indicates that better teeth and greater weight are found together.)

	B 13.	G 13.	B 13½.	G 13½.
D 1	+ ·2254 ± ·0766 †	− ·0387 ± ·0696 *	—	—
D 5	+ ·1290 ± ·0478 †	+ ·0081 ± ·0492 *	+ ·0973 ± ·0611 *	− ·0512 ± ·0672 *
D 3	+ ·0919 ± ·0552 *	+ ·1150 ± ·0563 †	+ ·0153 ± ·0594 *	− ·0244 ± ·0568 *
D 4	+ ·1490 ± ·0517 †	− ·1819 ± ·0497	+ ·0624 ± ·0529 *	− ·1281 ± ·0556 †
D 2	+ ·0716 ± ·0940 *	+ ·2646 ± ·0837	+ ·0776 ± ·0540 *	+ ·0727 ± ·0513 *

Mean r, weighting each value according to its P.E., is + ·0381 ± ·0136.

Although we were handicapped by not being able to group some of the data together and thus obtain a result which was based on a frequency of about 1000, yet when we find that separately the correlation coefficients are all small and doubtful, we can draw our conclusions as above with as much reliance as we should have been able to do, if it had been possible to combine our data as originally we had hoped.

(v) We pass now to the fundamental problem of this paper.

(*a*) We shall attempt to find expressions for the personal equations of the doctors from their distributions of teeth. Here we must remember that D 1 and D 5 take random samples from the same population and D 3 and D 4 also take random samples from another population, so that we can at most compare D 1 and D 5 together and D 3 and D 4 together.

Consider D 3, D 4.

We will assume that they take a sample from the same population given by

$$z = \frac{Ne^{-\frac{1}{2}x^2/\sigma^2}}{\sqrt{2\pi}\,.\,\sigma}, \text{ a normal distribution}$$

and that they then distort the distribution in some way, so as to produce another mean and another standard deviation.

Let us assume that the distribution given by D 3 for B 13 is

$$z = \frac{Ne^{-\frac{1}{2}x^2/\sigma_3^2}}{\sqrt{2\pi}\sigma_3}$$

and that the distance of the mean from the division line (O) between perfect and 1 carious tooth is m_3.

Then the equation of the distribution referred to O as origin is

$$Z = \frac{1}{\sqrt{2\pi}}\frac{Ne^{-\frac{1}{2}(x-m_3)^2/\sigma_3^2}}{\sigma_3}.$$

* $r < 2 \times$ P.E. † r between 2 and 3 × P.E.

Now suppose that in order to reduce this distribution given by D 3 to the original distribution of the population from which the sample was taken, we need only expand or compress the units of teeth represented along the axis Ox. That is to say, let us put $X = \lambda_3 x$ and $Z = z/\lambda_3$ since the total frequency is unaltered and we have the distribution given as

$$Z = \frac{1}{\lambda_3}\frac{Ne^{-\frac{1}{2}((X/\lambda_3)-m_3)^2/\sigma_3^2}}{\sqrt{2\pi}\sigma_3} = \frac{Ne^{-\frac{1}{2}(X-\lambda_3 m_3)^2/\lambda_3^2\sigma_3^2}}{\sqrt{2\pi}\sigma_3\lambda_3}.$$

Now if this is the equation to the original distribution, the original S.D. is $\lambda_3\sigma_3$ and the original mean, measured from the division line between perfect and 1 carious tooth is $\lambda_3 m_3$. Let us try this hypothesis, assuming in the case of D 3 a stretching of the x-unit represented by λ_3 and in the case of D 4 a stretching represented by λ_4. Let us denote the means and S.D.'s of the populations from which the samples were taken according to the following table :—

	S.D.	Mean.
B 13	σ	m
G 13	σ'	m'
B $13\frac{1}{2}$	σ''	m''
G $13\frac{1}{2}$	σ'''	m'''.

We know the means and S.D.'s of the distributions given by D 3 and D 4, so we shall get the following system of equations :—

B 13 . .	$1{\cdot}09486\,\lambda_3 - m = 0$	$1{\cdot}19312\,\lambda_4 - m = 0$
	$1{\cdot}43750\,\lambda_3 - \sigma = 0$	$1{\cdot}41763\,\lambda_4 - \sigma = 0$
G 13 . .	$0{\cdot}91406\,\lambda_3 - m' = 0$	$1{\cdot}18594\,\lambda_4 - m' = 0$
	$1{\cdot}55263\,\lambda_3 - \sigma' = 0$	$1{\cdot}48907\,\lambda_4 - \sigma' = 0$
B $13\frac{1}{2}$.	$1{\cdot}10909\,\lambda_3 - m'' = 0$	$1{\cdot}22148\,\lambda_4 - m'' = 0$
	$1{\cdot}47044\,\lambda_3 - \sigma'' = 0$	$1{\cdot}50068\,\lambda_4 - \sigma'' = 0$
G $13\frac{1}{2}$.	$1{\cdot}22293\,\lambda_3 - m''' = 0$	$1{\cdot}37838\,\lambda_4 - m''' = 0$
	$1{\cdot}64562\,\lambda_3 - \sigma''' = 0$	$1{\cdot}51230\,\lambda_4 - \sigma''' = 0$

There are 16 equations and we desire to find λ_3, λ_4, m, m', m'', m''', σ, σ', σ'', σ'''.

That is to say, there are 9 unknown ratios. We find the best value of these ratios by means of the principle of least squares ; they are :—

$$\begin{array}{ll}
\lambda_3 = {\cdot}766343\,m''' & \lambda_4 = {\cdot}743634\,m''' \\
m = {\cdot}86314\,m''' & \sigma = 1{\cdot}07791\,m''' \\
m' = {\cdot}79119\,m''' & \sigma' = 1{\cdot}14858\,m''' \\
m'' = {\cdot}87914\,m''' & \sigma'' = 1{\cdot}12141\,m''' \\
m''' = m''' & \sigma''' = 1{\cdot}19285\,m'''.
\end{array}$$

We have in λ_3 and λ_4 a means of comparing D 3 and D 4, for if we take D 4 as standard and assume $\lambda_4 = 1$, we have immediately $\lambda_3 = \dfrac{{\cdot}766343}{{\cdot}743634} = 1{\cdot}030538$ and the means and S.D.'s of the original populations from which D 3 and D 4 drew their samples are as below. These may be compared with the given means and S.D.'s of D 4.

	Mean.	S.D.	Mean D 4.	S.D. D 4.
B 13 . . .	1·1607	1·4495	1·1931	1·4176
G 13 . . .	1·0639	1·5445	1·1859	1·4891
B $13\frac{1}{2}$ . . .	1·1822	1·5080	1·2215	1·5007
G $13\frac{1}{2}$ . . .	1·3447	1·6041	1·3784	1·5123

Let us then apply this stretch λ_3 to the actual means and S.D.'s given by D 3 and we have—

	Mean.	S.D.
B 13	1·1283	1·4814
G 13	0·9420	1·6000
B 13½	1·1430	1·5153
G 13½	1·2603	1·6959

We may compare these also with the calculated means and S.D.'s of the supposed original population. Now the probable errors of the means and S.D.'s calculated from the given data are :—

	D 3.		D 4.	
	P.E. Mean.	P.E. S.D.	P.E. Mean.	P.E. S.D.
B 13	± ·0869	± ·0716	± ·08471	± ·0679
G 13	± ·0937	± ·0840	± ·08541	± ·0707
B 13½	± ·0946	± ·0790	± ·08979	± ·0750
G 13½	± ·1031	± ·0849	± ·09791	± ·0806

Thus the P.E.'s of the means and S.D.'s of the original population which are given above and which have been calculated as shown by solving certain equations by the methods of least squares, will be at least about ± ·10 and ± ·10. Comparing then the three tables of means and S.D.'s above, viz. of the original population, of D 4 and of D 3 modified by λ_3, and bearing in mind the size of the probable errors, we see that the differences between these three tables are not very great and we may infer that such stretching as is given by λ may represent the necessary change to make in D 3's distributions in order to reduce them to the standard of D 4.

To consider what λ means in terms of the distribution given by D 3, let us obtain, from the table of means and S.D.'s of D 3 after λ_3 has been applied, new distributions of the teeth in the three categories, Perfect : 1, 2 : the Rest, and compare these with those given by D 3, before any application of λ has taken place.

We have from the ratio $\frac{\text{mean}}{\text{S.D.}}$ the number in the "Perfect" category, and since the original mean and original S.D. are each multiplied by λ this ratio is unchanged and we still have the same number of cases in the first category; and

Further, since the breadth of the middle category is 2, we have from the ratios $\frac{2-\text{mean}}{\text{S.D.}}$ the numbers in the "Rest" class: thus we obtain the whole distribution, as below :—

	2 – mean.	$\frac{2-\text{mean}}{\text{S.D.}}$	$\frac{1}{2}(1+\alpha)$.	Total.	"Rest" Category.
B 13	·87171	·58844	·72188	242	67·31
G 13	1·05803	·66125	·74577	223	56·69
B 13½	·85704	·56558	·71416	213	60·88
G 13½	·73972	·43619	·66865	223	73·89

We have then these distributions—the supposed original distribution and that given by D 3 :—

B 13.				G 13.				B 13½.				G 13½.			
Pf.	1·2.	Rest.	T.	Pf.	1·2.	Rest.	T.	Pf.	1·2.	Rest.	T.	Pf.	1·2.	Rest.	T.
54	120·69	67·31	242	62	104·31	56·69	223	48	104·12	60·88	213	51	98·11	73·89	223
54	124	64	242	62	107	54	223	48	107	58	213	51	101	71	223
Difference	+ 3·31	− 3·31			+ 2·69	− 2·69			+ 2·88	− 2·88			+ 2·89	− 2·89	

From this table we see that D 3 compared with D 4 underestimates the number of carious teeth in the mouth and in consequence has slightly too many cases in the middle category and the same number too few in the "Rest" category. The percentages of the numbers placed in the wrong category to the total numbers examined are :—

B 13.	G 13.	B 13½.	G 13½.
1·37 per cent.	1·21 per cent.	1·35 per cent.	1·30 per cent.

so that we see roughly 1·3 per cent. of D 3's cases are placed in the wrong class and we could use this as a means of reducing teeth distributions given in future by D 3 to the same scale as that used by D 4, and when this has been done we could combine data given by D 4 and D 3.

We know that D 1 and D 5 take their samples from the same population. Let us then attempt to combine these two doctors as we combined the teeth distributions of D 3 and D 4.

We will denote the means and S.D.'s of the supposed original population, as follows :—

	Mean.	S.D.
B 13	M	Σ
G 13	M'	Σ'
B 13½ . . .	M''	Σ''
G 13½ . . .	M'''	Σ'''

Calling λ_1, λ_5 the stretching coefficients applied to D 1 and D 5 distributions respectively in order to reduce them to the original we shall get these equations :—

$$\begin{array}{lll}
\text{B 13 .} & 3{\cdot}38860\lambda_5 - M = 0 & 1{\cdot}73549\lambda_1 - M = 0 \\
 & 3{\cdot}69740\lambda_5 - \Sigma = 0 & 1{\cdot}60204\lambda_1 - \Sigma = 0 \\
\text{G 13 .} & 2{\cdot}79728\lambda_5 - M' = 0 & 1{\cdot}35480\lambda_1 - M' = 0 \\
 & 3{\cdot}10795\lambda_5 - \Sigma' = 0 & 1{\cdot}38164\lambda_1 - \Sigma' = 0 \\
\text{B 13½ .} & 3{\cdot}84057\lambda_5 - M'' = 0 & \\
 & 3{\cdot}60705\lambda_5 - \Sigma'' = 0 & \\
\text{G 13½ .} & 3{\cdot}47605\lambda_5 - M''' = 0 & \\
 & 2{\cdot}95085\lambda_5 - \Sigma''' = 0 &
\end{array}$$

Obtaining the best values of our unknowns from these equations we have :—

$$\lambda_1 = 2{\cdot}133259\lambda_5$$

$$\begin{aligned} M &= 3{\cdot}54543\lambda_5 & \Sigma &= 3{\cdot}55748\lambda_5 \\ M' &= 2{\cdot}84371\lambda_5 & \Sigma' &= 3{\cdot}02767\lambda_5 \\ M'' &= 3{\cdot}84057\lambda_5 & \Sigma'' &= 3{\cdot}60705\lambda_5 \\ M''' &= 3{\cdot}47605\lambda_5 & \Sigma''' &= 2{\cdot}95085\lambda_5 \end{aligned}$$

We can now compare D 1 and D 5, for if we assume D 5 is the standard then $\lambda_5 = 1$ and we have

$$\lambda_1 = 2{\cdot}133259 \text{ and}$$

$$\begin{aligned} &\text{B 13} \ldots & M &= 3{\cdot}5454 & \Sigma &= 3{\cdot}5575 \\ &\text{G 13} \ldots & M' &= 2{\cdot}8437 & \Sigma' &= 3{\cdot}0277 \\ &\text{B } 13\tfrac{1}{2} \ldots & M'' &= 3{\cdot}8406 & \Sigma'' &= 3{\cdot}6071 \\ &\text{G } 13\tfrac{1}{2} \ldots & M''' &= 3{\cdot}4760 & \Sigma''' &= 2{\cdot}9508 \end{aligned}$$

which are the means and S.D.'s of the original population from which D 5 and D 1 drew their samples.

We must compare these with the means and S.D.'s of the distributions given by D 5 and with those of the new distributions obtained by applying to D 1's distributions the λ_1 obtained above.

	D 5.		D 1.	
	Mean.	S.D.	Mean.	S.D.
B 13 . .	3·3886	3·6974	3·7022	3·4176
G 13 . .	2·7973	3·1079	2·8901	2·9474
B 13½ . .	3·8406	3·6071	—	—
G 13½ . .	3·4761	2·9509	—	—

Now the probable errors of the means and S.D.'s given by D 5 and D 1 are:—

	D 5.		D 1.	
	Mean.	S.D.	Mean.	S.D.
B 13 . .	± ·1966	± ·2953	± ·1527	± ·1219
G 13 . .	± ·1691	± ·2265	± ·1129	± ·0865
B 13½ . .	± ·2524	± ·3728	—	—
G 13½ . .	± ·2283	± ·2939	—	—

and the probable errors of the means and S.D.'s given above for the supposed original population will be at least of the order of ± ·20 and ± ·20, and we see that the differences between the means and S.D.'s in the tables above for the original population and for D 5 and D 1 modified by λ_1 are not unreasonable.

We note that whereas when we compared D 3 and D 4 the ratio of λ_3 to λ_4 was nearly unity, indicating that there was little difference between the judgments of teeth given by these two doctors, yet when we compare D 5 and D 1, we get the ratio of λ_5/λ_1 to be 2 roughly, indicating that D 1's judgment of teeth differs from D 5's judgment by a considerable amount. We will now investigate this point further

and attempt to translate λ_1/λ_5 into a simpler meaning of the difference between D 1 and D 5.

Let us then give the D 1 distributions the stretch λ_1 and find the new distributions corresponding to the means and S.D.'s we obtain in this way. We have:—

	Mean.	S.D.
B 13 . .	3·7022	3·4176
G 13 . .	2·8901	2·9474

The ratio $\frac{\text{mean}}{\text{S.D.}}$ will give us the number of cases in the "Perfect" category which will be the same as before since λ multiplies both the given mean and given S.D. to get the mean and S.D. of the original population. To get the numbers in the "Rest" category we take $\frac{2-\text{mean}}{\text{S.D.}}$:—

	2 – mean.	$\frac{2-\text{mean}}{\text{S.D.}}$.	$\frac{1}{2}(1+\alpha)$.	Number.	Rest Category.
B 13 . .	– 1·7022	– ·4981	·3092	122	84·28
G 13 . .	– ·8901	– ·3020	·3813	153	94·66

Thus we have:—

	B 13.				G 13.			
	Pf.	1·2.	Rest.	Total.	Pf.	1·2.	Rest.	Total.
Original distribution	17	20·72	84·28	122	25	33·34	94·66	153
Given distribution .	17	52	53	122	25	79	49	153
Difference . .		+ 31·28	– 31·28			+ 45·66	– 45·66	

That is to say compared with D 5, D 1 greatly underestimates the number of carious teeth in the mouth with the result that too many cases are placed in the middle category by this doctor and too few in the "Rest" category, the percentages of cases which are thus transferred being :—

B 13 . . .	25·64 per cent.
G 13 . . .	29·84 „ „

the mean of which is 28 per cent.

Thus the result of D1's under-estimate of the number of carious teeth in any child's mouth means that roughly 28 per cent. of the cases returned as having carious teeth at all are placed in the wrong class. We could use this figure to transfer any teeth data given by D 1 to the same standard as D 5, so that we could combine these two doctors' data.

Let us return to p. 18, and now take $\lambda_1 = 1$.

If we equate λ_1 to 1 and compare D 5 with D 1 we now get:—

B 13 . .	$M = 1{\cdot}6620$	$\Sigma = 1{\cdot}6676$
G 13 . .	$M' = 1{\cdot}3330$	$\Sigma' = 1{\cdot}4193$
B 13½ . .	$M'' = 1{\cdot}8003$	$\Sigma'' = 1{\cdot}6909$
G 13½ . .	$M''' = 1{\cdot}6295$	$\Sigma''' = 1{\cdot}3833$

The means and S.D.'s of the distributions from which D 5 and D 1 are supposed to have drawn their samples.

We shall compare with these the means and S.D.'s of the given distributions when they are modified by λ_5 and λ_1; we get as new means and S.D.'s for the D 5 distributions:—

	Mean.	S.D.
B 13 . . .	1·5885	1·7332
G 13 . . .	1·3113	1·4569
B 13½ . .	1·8003	1·6909
G 13½ . .	1·6295	1·3833

and for D 1 distributions:—

	Mean.	S.D.
B 13 . . .	1·7355	1·6020
G 13 . . .	1·3548	1·3816

so that we see these figures for the original given distributions conform very closely to the figures we have obtained on our hypothesis for the actual means and S.D.'s of the population from which the two doctors have sampled. We proceed as before to find the numbers of cases in the three teeth categories for the D 5 distributions:—

	2 − Mean.	$\frac{2 - \text{Mean}}{\text{S.D.}}$.	$\frac{1}{2}(1 + a)$.	Number.	Rest Category.
B 13 . .	·4115	·2374	·5938	345	140·13
G 13 . .	·6887	·4727	·6818	326	103·73
B 13½ . .	·1997	·1181	·5470	223	101·02
G 13½ . .	·3705	·2679	·6056	201	79·27

and we have:—

	B 13.				G 13.			
	Pf.	1·2.	Rest.	Total.	Pf.	1·2.	Rest.	Total.
Original distribution	62	142·87	140·13	345	60	162·27	103·73	326
Given distribution .	62	60	223	345	60	70	196	326
Difference . .		− 82·87	+ 82·87			− 92·27	+ 92·27	

	B 13½.				G 13½.			
	Pf.	1·2.	Rest.	Total.	Pf.	1·2.	Rest.	Total.
Original distribution	32	89·98	101·02	223	24	97·73	79·27	201
Given distribution .	32	36	155	223	24	38	139	201
Difference . .		− 53·98	+ 53·98			− 59·73	+ 59·73	

That is to say compared with D 1, D 5 greatly over-estimates the number of carious dentures with the result that too many cases occur in the "Rest" category and too few in the middle category, representing cases with slight caries. The percentages of cases thus transferred being :—

B 13.	G 13.	B 13½.	G 13½.
24·0 per cent.	28·3 per cent.	24·2 per cent.	29·2 per cent.

so that roughly 26·4 per cent. of cases are transferred in this way. This is practically the same figure as was obtained when we compared D 1 with D 5 as standard, and obtained the percentage of cases transferred by D 1.

Again, we could use this figure above to transfer any teeth data given by D 5 to the standard used by D 1.

We see from the above that D 5 compared with D 1 greatly over-estimates the number of carious teeth. This seems hardly likely, and we must look further for the cause of the discrepancy between these two doctors. We note, then, that in the above we have assumed that all the doctors mean by "Several" 3 carious teeth and more, because we have included the "Several" cases in the "Rest" category of the distributions. It may be that D 5 has used "Several" on occasions to indicate the presence of two carious teeth or possibly one carious tooth. We shall investigate this further when we try to find out what actually is meant by "Several".

(*b*) Proceeding with the discussion on the above results we see that in the case of the D 5 and D 1 combination, which represents a rural population, the means are in the neighbourhood of 3·5 when we regard D 5 as the standard, and in the case of the other combination D 3 and D 4, which represents a mining and industrial population the means are in the neighbourhood of 1·2. Now we should not anticipate that there would be any great difference between the means of these two types and must conclude that the standards we have taken D 5 and D 4 respectively are widely different in their returns of the number of carious teeth. When we use D 1 as the standard in our first combination we see that the means are in the neighbourhood of 1·5 which is more in agreement with the results obtained from the D 3 and D 4 combination. From this we would infer that D 1 should be taken as the standard in the first group in preference to D 5, and inquiry reveals the fact that in the medical inspection for 1911, three doctors D 1, D 3, and D 4 arranged to hold a more detailed inspection of the mouths, reporting discoloration, uncleanness, etc., in addition to caries. We shall refer to the matter later when discussing the association between cleanliness of the teeth and caries. This fact leads us, then, to take D 1 as the standard in the first combination, since the figures given by this doctor are probably the result of more careful examination of the teeth, and D 5's distributions as given must be modified by assuming that the number of carious teeth is over-estimated or we must conclude that we have been wrong in assuming that this doctor denotes by "Several" three or more carious teeth. As the

first alternative seems rather impossible we shall investigate the D 5 distributions on the assumption that "Several" in this case means one, two, or more carious teeth. This alternative also appears artificial, in so far that it does not seem likely that a doctor would describe a case as having several carious teeth when only one was in that condition, but we will work with the data on this assumption and compare the results with the previous results obtained on the other assumptions. When we look again at the original teeth distributions we see that we must modify our first idea of what the various doctors meant by "Several".* We have supposed that "Several" meant any number of teeth beyond the highest number returned by the doctor in any distribution. Thus D 1 returns, in the B 13 distribution, two cases having seven carious teeth and we assumed that "Several" meant eight or more, and similarly with the others. But closer inspection of these distributions reveals the fact that it is really impossible to attach this meaning to the numbers returned as "Several," and especially is this the case with D 5. To the tail of a distribution of teeth such as :—

0.	1.	2.	3.	4.	5.
64	36	25	7	—	1

we cannot fit 227 cases starting at six teeth, and we are driven to the conclusion that these 227 cases must include some with two carious teeth and possibly some with one carious tooth. Similarly with D 1 and D 2; we must conclude that "Several" includes cases of five and more carious teeth. With the D 3 distributions we can assume quite reasonably that "Several" means five and more. Such modifications of our impression of the meaning of "Several" will not invalidate the previous work where we have taken the teeth as divided into three categories (because in effect in this work we have assumed that "Several" may mean three and more), except in the case of D 5, and here we see the reason why on our previous assumption the means and S.D.'s for the D 5 distributions were so widely different from those of the other distributions. Again when comparing D 5 and D 1 we said, taking D 1 as standard, that we must take out some of the cases from D 5's "Rest" categories and put them in the middle categories, which is equivalent to saying that our tacit assumption that D 5 means by several three or more, must be modified and must mean two or more, or possibly one or more. If we agree to assume that in this case "Several" includes cases of two carious teeth only, we may just as reasonably go one step further and assume that "Several" also includes some cases of one carious tooth.

So far we conclude then, on the evidence before us that we were wrong to suggest D 5 as the standard in the first combination, that the returns of D 1, D 3, and D 4 are probably the best since these doctors made a more careful investigation of

* Inquiries made recently, i.e. 10 years after the original observations, were not successful in throwing any light on the meaning of "Several".

the state of the mouth; that the mean number of carious teeth for children of these ages under consideration is in the region of 1·4 (we see that we get figures of the same order in the D 2 distributions), that the standard deviations of the distributions are all in the neighbourhood of 1·5, that D 5 means by "Several" one or more carious teeth, and that D 1, D 2, and D 3 mean by "Several" five or more carious teeth. We cannot get any reasonable comparison between the different types of population as represented by the various combinations because there is apparently no consistent change from B to G groups or from 13 to 13½ groups as the table shows.

	D 1, D 5 Combination.		D 3, D 4 Combination.		D 2.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
B 13 . . .	1·66	1·67	1·16	1·45	1·65	1·23
G 13 . . .	1·33	1·42	1·06	1·54	1·30	3·09
B 13½ . . .	1·80	1·69	1·18	1·51	1·04	2·07
G 13½ . . .	1·63	1·38	1·34	1·60	1·03	1·71

These results are, of course, obtained on the assumption that the distributions are approximately normal or Gaussian.

When we examine the table of the teeth distributions for the various age and sex groups given by the different doctors, we see immediately that a difficulty arises in the interpretation of the "Several" groups which occur in these distributions. We shall attempt to find out what each doctor means by "Several," using the knowledge we have already obtained, that the data given by D 1 and D 5 can be combined and that the data given by D 3 and D 4 can also be combined.

(1) *D* 1 *and D* 5.—We see from the distributions that it is fair to assume that D 1 has used the word "Several" to indicate in certain cases children who have five or more teeth carious, and that D 5 has used the word in a different sense, viz. to indicate cases which occur of one or more teeth carious. We shall assume that this is the case. We shall also assume that each doctor is consistent in taking the same proportions from each group to form the "Several" group. We shall have then the following distributions given by D 5 :—

	Pf.	1.	2.	3.	4.	5.	6.	7.
B 13	64	$36 + 227\lambda_1$	$25 + 227\lambda_2$	$7 + 227\lambda_3$	$227\lambda_4$	$1 + 227\lambda_5$	$227\lambda_6$	$227\lambda_7$
G 13	61	$38 + 191\lambda_1$	$34 + 191\lambda_2$	$7 + 191\lambda_3$	$5 + 191\lambda_4$	$1 + 191\lambda_5$	$191\lambda_6$	$191\lambda_7$
B 13½	36	$21 + 165\lambda_1$	$16 + 165\lambda_2$	$3 + 165\lambda_3$	$165\lambda_4$	$165\lambda_5$	$165\lambda_6$	$165\lambda_7$
G 13½	25	$19 + 139\lambda_1$	$22 + 139\lambda_2$	$6 + 139\lambda_3$	$7 + 139\lambda_4$	$139\lambda_5$	$139\lambda_6$	$139\lambda_7$

where λ_1, λ_2, etc., are to be determined.

We shall have the distributions given by D 1 :—

	Pf.	1.	2.	3.	4.	5.	6.	7.	8.
B 13	24	26	34	24	15	$5 + 9\mu_5$	$4 + 9\mu_6$	$2 + 9\mu_7$	$9\mu_8$
G 13	33	40	58	17	22	$9 + 8\mu_5$	$3 + 8\mu_6$	$8\mu_7$	$8\mu_8$

where the μ's are to be determined.

We find the λ's and μ's by the method of least squares assuming that the distributions of these two doctors are random samples from the same population. As D 1 only deals with B 13 and G 13 we can only use these two of the distributions to find our λ's and μ's.

Let us consider the distribution B 13. Divide the frequency in each group by the total: we have :—

	Pf.	1.	2.	3.	4.	5.	6.	7.
D 5	·1778	$\cdot 1000 + \cdot 6306\lambda_1$	$\cdot 0694 + \cdot 6306\lambda_2$	$\cdot 0194 + \cdot 6306\lambda_3$	$\cdot 6306\lambda_4$	$\cdot 0028 + \cdot 6306\lambda_5$	$\cdot 6306\lambda_6$	$\cdot 6306\lambda_7$
D 1	·1678	·1818	·2378	·1678	·1049	$\cdot 0350 + \cdot 0629\mu_5$	$\cdot 0280 + \cdot 0629\mu_6$	$\cdot 0140 + \cdot 0629\mu_7$

When finding the probability that these two distributions are samples from the same population, we take the differences in the above series, we square these differences, etc., and obtain a χ^2. This χ^2 must be small in order that the two distributions shall belong to the same population, so that we get equations for λ's and μ's by considering that these differences are as small as possible and actually assuming them to be zero. We then have these equations :—

$$\cdot 6306\,\lambda_1 = \cdot 0818\,;\ \cdot 6306\,\lambda_2 = \cdot 1684\,;\ \cdot 6306\,\lambda_3 = \cdot 1484\,;\ \cdot 6306\,\lambda_4 = \cdot 1049\,;$$
$$\cdot 6306\,\lambda_5 - \cdot 0629\,\mu_5 = \cdot 0322\,;\ \cdot 6306\,\lambda_6 - \cdot 0629\,\mu_6 = \cdot 0280\,;$$
$$\cdot 6306\,\lambda_7 - \cdot 0629\,\mu_7 = \cdot 0140\,;\ \cdot 6306\,\lambda_8 - \cdot 0629\,\lambda_8 = 0, \text{ etc.}$$

We get similar equations when we consider in the same way the distributions of carious teeth for G 13. They are :—

$$\cdot 5668\,\lambda_1 = \cdot 0977\,;\ \cdot 5668\,\lambda_2 = \cdot 2044\,;\ \cdot 5668\,\lambda_3 = \cdot 0687\,;\ \cdot 5668\,\lambda_4 = \cdot 1010\,;$$
$$\cdot 5668\,\lambda_5 - \cdot 0421\,\mu_5 = \cdot 0444\,;\ \cdot 5668\,\lambda_6 - \cdot 0421\,\mu_6 = \cdot 0158\,;$$
$$\cdot 5668\,\lambda_7 - \cdot 0421\,\mu_7 = 0\,;\quad \cdot 5668\,\lambda_8 - \cdot 0421\,\mu_8 = 0, \text{ etc.}$$

At present there is no limit fixed to the number of λ's and μ's.

We remember that

$$\lambda_1 + \lambda_2 + \lambda_3 + \ldots = 1$$
$$\mu_5 + \mu_6 + \mu_7 + \ldots = 1$$

so that our λ's and μ's must be such that they fulfil these conditions.

We find actually when we get the best λ's and μ's to satisfy these equations that we have :—

$\lambda_1 = \cdot 1513$ $\mu_5 = \cdot 9250$
$\lambda_2 = \cdot 3089$ $\mu_6 = \cdot 0750$
$\lambda_3 = \cdot 1847$ and λ_7, λ_8, etc. $= 0$
$\lambda_4 = \cdot 1716$ μ_7, μ_8, etc. $= 0$.
$\lambda_5 = \cdot 1582$
$\lambda_6 = \cdot 0253$

Using these λ's and μ's to interpret the "Several" categories of D 5 and D 1 we see that we have :—

TEETH DISTRIBUTIONS.

B 13.	Pf.	1.	2.	3.	4.	5.	6.	7.	Totals.
D 5 .	64	70·3	95·1	48·9	38·9	36·9	5·7	—	359·8
D 1 .	24	26	34	24	15	13·3	4·7	2	143

The probability P obtained by using the test that these distributions should be random samples from the same population is ·36 which indicates that so far the method assumed above is justifiable since it does conform with previous experience on the height and weight distributions.

G 13.	Pf.	1.	2.	3.	4.	5.	6.	7.	Totals.
D 5 .	61	66·9	93·0	42·3	37·8	31·2	4·8	—	337
D 1 .	33	40	58	17	22	16·4	3·6	—	190

For girls P is ·9 ; which again helps to justify the method used.

Using the same λ's we can obtain the distributions for D 5, B 13½, G 13½ :—

D 5.

	Pf.	1.	2.	3.	4.	5.	6.	Totals.
B 13½	36	46	67	33·5	28·3	26·1	4·2	241·1
G 13½	25	40	64·9	31·7	24·9	22	3·5	212

We will note here that these distributions are all definitely skew.

We proceed to obtain the means and S.D.'s of these distributions separately with the following results :—

	D 5.		D 1.	
	Mean.	S.D.	Mean.	S.D.
B 13 . . .	2·1720 ± ·0566	1·5934	2·0007 ± ·0988	1·7521
G 13 . . .	2·1240 ± ·0576	1·5682	2·0979 ± ·0765	1·5633
B 13½ . . .	2·2787 ± ·0685	1·5775		
G 13½ . . .	2·3373 ± ·0700	1·5102		

If we now combine these figures we obtain means which will represent the mean number of carious teeth in children in the rural region in the middle of the county. They are :—

B 13	$2{\cdot}1233 \pm {\cdot}0491$
G 13	$2{\cdot}1708 \pm {\cdot}0460$
B $13\frac{1}{2}$ . . .	$2{\cdot}2787 \pm {\cdot}0685$
G $13\frac{1}{2}$ . . .	$2{\cdot}3373 \pm {\cdot}0700$

and it will be seen that the means in each age group are greater for girls than for boys, and though the differences are not actually significant yet they may be of some importance since they exist for both age groups : in addition, we note that the older children have on the average more carious teeth than the younger, the differences here being greater than before, though still not very significant, but these differences again gain weight from the fact that they occur for both the sex groups. Such increase in the number of carious teeth with age we might anticipate.

In addition the above tables of means and standard deviations for the two doctors, agreeing as well as they do, help to justify the original assumptions on which the method outlined above was based, and indicate that it is extremely probable that these assumptions and the consequent values of the λ's and μ's are near the truth. In this way we have obtained a method of actually redistributing the "Several" totals into the groups from which they were drawn and the manner of this redistribution in each case gives some indication of the personal equation of the two doctors. From the μ's we see that D 1's "Severals" should really be mostly in the "5" group with a smaller percentage in the "6" group : while D 5's "Severals" are to be distributed among all the groups from 1 to 6 in a fashion which can be seen at sight, from an inspection of the λ's, to be similar to the skew distributions obtained above for the different groups when we substituted for the λ's and μ's.

Now we wish to compare this method of dealing with the distributions with our first method. That method gave us, when we compared D 5 with D 1, the result that we must transfer roughly 26 per cent. from the "Rest" category to the middle category. In our later method of dealing with these distributions we have assumed "Several" to include possibly cases of one and two carious teeth, and if we find out the percentages of these cases to the whole frequency we have a figure which we can compare with that obtained by the first method.

We have the table given on the opposite page, and we find the average amount transferred is 29 per cent. ; thus we obtain practically the same figure as before, which was 26 per cent. Judged from this standpoint the two methods of dealing with the distributions give the same result.

But when we compare the means and standard deviations obtained by the two methods we see that there is a very significant difference between the means. By the second method they are in the neighbourhood of 2·1, whereas by the first method they

D 5. *Given Distribution in Three Categories and Modified Distribution in Three Categories.*

		Pf.	1·2.	Rest.	Total.	
B 13	Given	64	61	235	360	$\frac{104\cdot5}{360} = 29\cdot0$ per cent.
	New	64	165·4	130·4	359·8	
	Difference	—	104·4	104·6	—	
G 13	Given	61	72	204	337	$\frac{87\cdot9}{337} = 26\cdot1$,, ,,
	New	61	159·9	116·1	337	
	Difference	—	87·9	87·9	—	
B 13½	Given	36	37	168	241	$\frac{76}{241} = 31\cdot5$,, ,,
	New	36	113	92·1	241·1	
	Difference	—	76	75·9	—	
G 13½	Given	25	41	146	212	$\frac{64}{212} = 30\cdot2$,, ,,
	New	25	104·9	82·1	212	
	Difference	—	63·9	63·9	—	

are smaller, nearer to 1·5. This difference is due to the fact that when working with the distributions in three categories we assumed normality for the distributions, whereas by the second method we have made no such assumption and have found the means and standard deviations from the distributions modified by the λ's and μ's. We can compare the differences obtained in this way with the differences in the means of D 4's distributions (i) when the distributions are assumed to be normal; (ii) when the actual distributions as given are used to obtain the mean.

D 4. Means of distributions.

	(i) Assuming Normality.	(ii) Distribution as given (Skew).
B 13	1·1931	1·8203
G 13	1·1859	1·9681
B 13½	1·2215	1·8859
G 13½	1·3784	2·0207

Here again we see the same difference between the means obtained in this way and we realise, in these cases of very skew distributions, how badly the Gaussian fits the actual figures.

So far then we have obtained a result which expresses the difference between D 1 and D 5, which we might term the "personal equation" in the matter of teeth distributions, and which results from an attempt to interpret "Several". D 1 classes as "Several" some cases of five carious teeth and fewer cases of six carious teeth, whereas D 5 puts in the "Several" class, some cases of one, two, three, four, five, six carious teeth. We will now deal with these results in another way.

Consider D 1. We have come to the conclusion that the tails of the distributions given by this doctor should be :—

No. of Carious Teeth.	5.	6.	7.
B 13 .	13·3	4·7	2
G 13 .	16·4	3·6	—

whereas they are given

No. of Carious Teeth.	5.	6.	7.	Sev.
B 13 .	5	4	2	9
G 13 .	9	3	—	8

That is to say 8·3 cases out of 13·3 of five carious teeth are returned as "Several,"
7·4 „ „ 16·4 „ „ „ „ „
these figures give us 62 per cent. and 45 per cent., i.e. roughly about 50 per cent. of cases of five carious teeth are returned by this doctor as "Several".

Again ·7 cases out of 4·7 of six carious teeth are returned as "Several,"
and ·6 „ „ 3·6 „ „ „ „ „
which give us 15 per cent. and 17 per cent., i.e. roughly about 16 per cent. of cases of six carious teeth are returned as "Several".

Consider D 5. The distributions given and modified are:—

B 13.	Pf.	1.	2.	3.	4.	5.	6.	Sev.
New .	64	70·3	95·1	48·9	38·9	36·9	5·7	—
Given .	64	36	25	7	—	1	—	227
Diff. .	—	34·3	70·1	41·9	38·9	35·9	5·7	—
% Diff./New	—	49	74	86	100	97	100	—

G 13.	Pf.	1.	2.	3.	4.	5.	6.	Sev.
New .	61	66·9	93·0	42·3	37·8	31·2	4·8	—
Given .	61	38	34	7	5	1	—	191
Diff .	—	28·9	59·0	35·3	32·8	30·2	4·8	—
% Diff./New	—	43	63	84	87	97	100	—

B 13½.	Pf.	1.	2.	3.	4.	5.	6.	Sev.
New .	36	46	67	33·5	28·3	26·1	4·2	—
Given .	36	21	16	3	—	—	—	165
Diff. .	—	25	51	30·5	28·3	26·1	4·2	—
% Diff./New	—	54	76	91	100	100	100	—

G 13½.	Pf.	1.	2.	3.	4.	5.	6.	Sev.
New .	25	40	64·9	31·7	24·9	22	3·5	—
Given .	25	19	22	6	1	—	—	139
Diff. .	—	21	42·9	25·7	23·9	22	3·5	—
% Diff./New	—	52	66	81	96	100	100	—

We see from this table that roughly:—

Of the cases of 1 carious tooth D 5 returns 50 per cent. as "Several".
„ „ 2 „ teeth „ „ 70 „ „
„ „ 3 „ „ „ „ 85 „ „
„ „ 4 „ „ „ „ 95 „ „
„ „ 5 „ „ „ „ all as "Several".
„ „ 6 „ „ „ „ all „ „

These figures are of course approximate and are based on the assumptions stated above that this doctor's "Several" may include all numbers of carious teeth, such an assumption being indicated as necessary when we consider the distributions by the

first method, and fairly justified when we see the agreement between the means and standard deviations obtained from all the distributions given by D 1, D 5, D 3, D 4. But we would emphasise the great difference between this doctor and the other doctor D 1 (and later we shall see between this doctor and D 3 and D 4) in the returns of carious teeth, and how necessary it is to consider whether the personal equation enters into such returns, before all the data given by different doctors are grouped together, and general conclusions are drawn from such grouped data. In such a case as these teeth distributions discussed here, there is no justification for grouping all the data together, because the basic scale used by D 5 is absolutely different from that used by the other doctors and such a combination of the data would be equivalent to taking the measurements of the height of 500 school children in inches and of another 500 in centimetres, combining the two sets of data as though the scales were the same and presenting the resultant mean in inches. In this way our children would grow taller by the stroke of a pen.

(2) *D* 3 *and D* 4.—Similar treatment in the case of the distributions given by these two doctors, enables us to find the meaning of the word "Several" used by D 3. D 4 only uses the word in the case of G 13½ and for simplicity we shall reject that case from the distribution. We are led to conclude that D 3 means by "Several" five or more carious teeth, from a glance at the table showing the original distributions and we shall make this assumption in what follows.

Using λ_5, λ_6, λ_7, λ_8, to represent the proportions into which the "Several" category is to be redistributed into the 5, 6, 7, 8 groups, we get :—

$$\lambda_5 = \cdot 55700$$
$$\lambda_6 = \cdot 31681$$
$$\lambda_7 = \cdot 07516$$
$$\lambda_8 = \cdot 05101$$

These λ's give us new distributions :—

D 3.	Pf.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
B 13	60	37	95	36	18	6·5	3·2	·8	·5	257
G 13	66	36	80	25	24	4·5	2·5	·6	·4	239
B 13½	49	28	84	27	19	7·8	4·4	1·1	·7	221
G 13½	58	49	64	25	25	15	8·6	2	1·4	248

and the probabilities obtained when these are compared with the D 4 distributions are :—

B 13	G 13	B 13½	G 13½
·05	·07	·02	·2

When we compare the tails of D 3's distributions before and after modification by the λ's we see that, roughly speaking, all cases of five, six, seven, and eight carious teeth are placed by this doctor in the "Several" category. This is the personal

equation of this doctor when dealing with the "Several" category. But we note further difference between this doctor and D 4. The distributions given by these two doctors should be random samples from the same population, but an examination into this point reveals the fact that only in one case (G $13\frac{1}{2}$) is there reasonable agreement between the two doctors. A glance at the original distributions immediately shows that the main difference between the distributions lies in the relative frequencies occurring in the one and two carious teeth groups. We can appreciate this further when we refer back to the first method of treatment of the teeth distributions, i.e. in three categories on the assumption of normality, for then we saw that there was practically no difference between the D 3 and D 4 distributions—and there we had put into one group all cases of one and two teeth carious. This is also consistent with the fact that the means and standard deviations of the distributions given by these doctors are practically the same, the means being in the region of 1·8 to 2·0, so that any differences between distributions which involve the frequencies in the 1 and 2 groups would not be reproduced in the means and standard deviations.

Further, if in the D 3 and D 4 distributions we group one and two teeth together as one group we find immediately that we get very different results in testing whether these distributions are random samples of the same population, for now we have the following probabilities :—

B 13	G 13	B $13\frac{1}{2}$	G $13\frac{1}{2}$
·92	·17	·90	·15.

These results are sufficiently good for us to proceed to inquire into the reason why such a grouping of one and two together should bring about such a change. One might suggest that these doctors differ in the number of cases which should be classed as having one carious tooth and those which should be classed as having two carious teeth.

When we consider that it is a question of one or two teeth being carious, there may be cases where D 3 has observed a carious tooth and after further examination has found another where caries is just starting and such cases D 3 has classed as two carious teeth. D 4 examining the same mouth may have rejected the slightly carious tooth as not to be returned and classed such a case as one carious tooth. In older children this slightly carious tooth will have become more carious and less difference will be expected between the two doctors in the return of one and two carious teeth. If we compare the B 13 distributions and the G $13\frac{1}{2}$ distributions on this point we see immediately that here we have a comparison between the two extremes of our four age and sex groups, for girls approaching puberty are older than boys of the same age in physical development. We find the probability from the B 13, D 3, D 4 distributions above is ·05 and becomes ·92 when the 1 and 2 groups are combined. From the G $13\frac{1}{2}$ D 3, D 4 groups we have originally ·2 becoming ·15 after the combination of the two groups. In fact the latter distributions are

so closely in agreement before the change, that the change merely lowers the number of classes in the distributions and consequently lowers the probability.

Thus we suggest that the large difference between these two doctors is due to the presence of slightly carious teeth which are returned as carious by one doctor and are not returned by the other doctor. If this happens when there were three or four carious teeth, it is not emphasised in the distributions owing to the smaller numbers of such cases occurring.

(3) We note, if we assume that D 5 means by "Several" two or more, that we shall get the same kind of distribution of frequency as is given by D 3, for we should then have less numbers in the 1 group than in the Pf and 2 groups on either side of it. Suppose then that we make this assumption and attempt to fit by the same method as before the D 5 and D 1 distributions, and obtain in this way new λ's and μ's. We find:—

$$\begin{aligned} \lambda_2 &= \cdot 32804 & \quad \text{and } \mu_5 &= 1 \\ \lambda_3 &= \cdot 20351 & \quad \mu_6 \text{ etc.} &= 0 \\ \lambda_4 &= \cdot 19082 \\ \lambda_5 &= \cdot 17079 \\ \lambda_6 &= \cdot 05620 \\ \lambda_7 &= \cdot 03146 \\ \lambda_8 &= \cdot 01918 \end{aligned}$$

are the values which give the best results for the equations we have for the λ's and μ's and we see that now the λ's gradually decrease.,

If we use these figures and compare the D 5 and D 1 distributions now for B 13 and G 13, taking as one group 1, 2 teeth carious we have probabilities of ·85 for the B 13 distributions and ·1 for the G 13 distributions, and we have these means, taking the 1 and 2 groups as one single group at 1·5.

	D 5.	D 1.	Average of D 5 and D 1.
B 13	2·4888	2·3077	2·4373 ± ·0582
G 13	2·3951	2·0474	2·2697 ± ·0505
B 13½	2·6392	—	2·6392 ± ·0819
G 13½	2·6439	—	2·6439 ± ·0839

Similarly if we find the means of the D 3 and D 4 distributions when the 1, 2 groups are put together, the total frequency being considered as concentrated at 1·5, we get:—

	D 3.	D 4.	Average of D 5 and D 1.
B 13	1·7105	1·8153	1·7665 ± ·0401
G 13	1·6314	1·9345	1·8033 ± ·0425
B 13½	1·8267	1·8840	1·8579 ± ·0460
G 13½	2·0020	1·9835	1·9929 ± ·0497

(4) *D* 2.—We do not feel justified in comparing this doctor with any of the others, but we note that, except in the B 13 distribution, there is again the same kind of " dip " in the frequency at the " 1 " group as we observe in D 3's distributions, and we feel justified in assuming that we may redistribute the "Several " cases amongst the groups from 5 onwards in the same way that we have used for the other doctors —that is to say, more in group 5 than in group 6, more in 6 than in 7, etc. To do this we use the Poisson series for $m = 0{\cdot}4$ (Tables for Statisticians) and we obtain these new distributions:—

	Pf.	1.	2.	3.	4.	5.	6.	7.	8.	
B 13	15	26	49	20	19	11·4	7·3	0·3	2	150
G 13	45	27	43	28	15	11	3·4	4·5	2·1	179
B 13½	76	42	53	27	12	30·1	8·4	3·3	0·2	252
G 13½	76	50	73	36	18	16	9·2	1·6	0·1	280

the means of which, obtained by grouping the 1 and 2 frequencies together at 1·5 are :—

B 13 . . . . $2{\cdot}4493 \pm {\cdot}0925$
G 13 . . . . $2{\cdot}0821 \pm {\cdot}0922$
B 13½ . . . $1{\cdot}9726 \pm {\cdot}0803$
G 13½ . . . $1{\cdot}8282 \pm {\cdot}0661$

We see that the means for the urban children B 13½, G 13½ conform fairly well to those already obtained for similar types of children in the D 3, D 4 districts, and are rather different from these obtained in the D 5 area, which is comparatively much more rural than the others. The result for the B 13 distribution seems to differ greatly from the others, but we must point out that here there are 150 cases and the probable error is in consequence larger.

A comparison of these tables of means gives us the following results :—

(*a*) On the whole the mean number of carious teeth is greater in country districts than in towns and mining districts.

(*b*) The mean number of carious teeth is about two in children of 13 and 13½.

(*c*) From the D 5, D 1 and D 3, D 4 combinations we see that the older children have on the average slightly more carious teeth. In many cases these children had carious milk teeth, though the total numbers of milk teeth recorded for the later age groups is much less than those recorded for the earlier age groups, which is consistent with the fact that they would discard them with increasing age. Taking these two facts together we see that there is a definite increase in the number of permanent teeth carious as we pass from the 13 group to the 13½ group. D 2's results contradict those of the other doctors, there is some decrease in the average number of carious teeth with age, but we would rather lay more stress on results obtained from the other four doctors on account of the fact that we have been unable to compare D 2 with any of them.

(*d*) There is no real difference discernible between the sexes in the matter of carious teeth.

When we consider the meaning of the λ's in the case of D 2 we have these figures for the tails of the distributions given by this doctor :—

	Modified.				Given.				Difference.			
	5.	6.	7.	8.	5.	6.	7.	8.	5.	6.	7.	8.
B 13	11·4	7·3	0·3	2	8	6	0	2	3·4	1·3	0·3	0
G 13	11	3·4	4·5	2·1	5	1	4	2	6	2·4	0·5	0·1
B 13½	30·1	8·4	3·3	0·2	14	2	2	0	16·1	6·4	1·3	0·2
G 13½	16	9·2	1·6	0·1	8	6	1	0	8	3·2	0·6	0·1

We find that out of :—

68·5 cases of 5 carious teeth D 2 returns 33·5 as "Several," i.e. 49 per cent.
28·3 „ 6 „ „ 13·3 „ „ 47 „
9·7 „ 7 „ „ 2·7 „ „ 28 „
4·4 „ 8 „ „ 0·4 „ „ 9 „

That is to say D 2 returns roughly 50 per cent. of cases of five and six carious teeth as "Several," 30 per cent. of cases of seven carious teeth and 10 per cent. of cases of eight carious teeth.

This may be regarded as this doctor's personal equation.

When we consider again the new λ's obtained for D 5, we assumed that "Several" meant two or more. We have in the following table the modified and given tails.

	Modified.							Given.				Difference.						
	2.	3.	4.	5.	6.	7.	8.	2.	3.	4.	5.	2.	3.	4.	5.	6.	7.	8.
B 13 . . .	99·5	53·2	43·3	39·8	12·8	7·1	4·3	25	7	—	1	74·5	46·2	43·3	38·8	12·8	7·1	4·3
G 13 . . .	96·7	45·9	41·4	33·6	10·7	6·0	3·7	34	7	5	1	62·7	38·9	36·4	32·6	10·7	6·0	3·7
B 13½ . . .	70·1	36·6	31·5	28·2	9·3	5·2	3·2	16	3	—	—	54·1	33·6	31·5	28·2	9·3	5·2	3·2
G 13½ . . .	67·6	34·3	27·5	23·7	7·8	4·4	2·7	22	6	1	—	45·6	28·3	26·5	23·7	7·8	4·4	2·7

The resulting percentages of these differences on the modified frequencies are :—

	2.	3.	4.	5.	6.	7.	8.
B 13	74·9	86·8	100	97·5	100	100	100
G 13	64·8	84·7	87·9	97·0	100	100	100
B 13½	77·2	91·8	100	100	100	100	100
G 13½	67·5	82·5	96	100	100	100	100
Average	71·1	86·5	96·0	98·6	100	100	100

So that we see, roughly, that D 5 returns 70 per cent. of cases of two carious teeth as "Several," 85 per cent. of three carious teeth and all others four, five, six, seven, and eight, as "Several," and that this agrees very closely with what we obtained before when we assumed that "Several" included one or more carious teeth.

With regard to D 1 we see that as we had $\mu_5 = 1$ and μ_6, μ_7, etc., $= 0$ we get practically the same result as before, out of thirty-one cases of five carious teeth seventeen are returned as "Several," or roughly 50 per cent.

When we compare the doctors from the point of view of the meaning they attach to the word "Several" we see that D 1, D 2, and D 3 are not very different: they class as "Several" only a small proportion of the total frequencies occurring and most of these cases are cases of five or more carious teeth. D 5 on the other hand uses the word to indicate many cases of two, three, and four carious teeth, and is in this way very different from the others. If the medical inspection is primarily instituted for the purpose of finding out what is necessary for the improvement of the children's health, such classification is presumably sufficient, but if the records thus obtained are all grouped together and analysed for the purposes of an official report, then it is necessary to be sure that the same methods were used by different doctors, otherwise the results obtained must be valueless. We would emphasise this point and further remark—that if we get such differences between doctors serving in one county and under one administration, we must expect even greater differences in the different administrations in several parts of the country. If we wish to combine or compare results obtained for various parts of England, we must be sure that the same standards are used in observations by all the bodies which organise any inspection or examination, and that the individuals serving under these bodies actually are standardised so that the same report would be made by one person after examining a group of people as would be made by any other. Without such standardisation there is no justification for comparing town with town, county with county or more generally country with country, etc., as is often at present done on the basis of such examinations.

IV. NUTRITION.

(i) Turning now to the question of nutrition and the possible effect of bad teeth on nutrition we have the following distributions given by the various doctors for the different groups of children.

Nutrition is divided into four categories, good, normal, subnormal, and bad (see opposite page).

An examination of these distributions reveals the fact that most doctors have the greatest number in the normal category, and that here again the personal equation enters, for D 1 has more in the "Good" category than in the "Subnormal" category and both are small compared with those in the "Normal" category; D 5 has a much bigger proportion outside the "Normal" group with most in the "Sub-

B 13.	D 1.	D 2.	D 3.	D 4.	D 5.
Good.	5	27	11	9	27
Normal	136	112	189	230	227
Subnormal	2	10	57	56	105
Bad	—	1	—	—	1
Total	143	150	257	295	360

G 13.	D 1.	D 2.	D 3.	D 4.	D 5.
Good.	17	55	21	31	
Normal	171	116	171	217	189
Subnormal	2	8	47	65	99
Bad	—	—	—	—	1
Total	190	179	239	313	337

B 13½.	D 1.	D 2.	D 3.	D 4.	D 5.
Good.	—	34	5	10	5
Normal	16	208	174	209	162
Subnormal	—	10	42	42	72
Bad	—	—	—	2	2
Total	16	252	221	263	241

G 13½.	D 1.	D 2.	D 3.	D 4.	D 5.
Good.	—	63	48	34	18
Normal	10	203	146	167	140
Subnormal	—	14	54	42	52
Bad	—	—	—	—	2
Total	10	280	248	243	212

normal": again D 3 and D 4 have larger numbers in the outer groups with more in "Subnormal" than in "Good" while D 2 has more in "Good" than in "Subnormal". Also none of the doctors place many cases in the "Bad" group, which therefore in future will be classed with "Subnormal," and "Good" and "Normal" will be grouped together, thus making two groups called "Normal" and "Subnormal". We cannot group all our doctors together on account of the essential differences of the three types of population and we cannot group D 3 and D 4 together or D 1 and D 5 together on account of the differences in their judgment of nutrition and teeth. So we must find the correlation coefficients separately for each doctor and each group between teeth and nutrition, having two teeth groups as before and two nutrition groups as outlined above. We found the "tetrachoric" correlation coefficients and we have these results :—

TEETH AND NUTRITION.

Table of Correlation Coefficients.

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	− ·1514 ± ·2368 *	− ·1355 ± ·1366 *	+ ·1664 ± ·0735 †	+ ·2220 ± ·0688	+ ·2870 ± ·0591
G 13	+ ·5390 ± ·1799 †	− ·1176 ± ·1391 *	+ ·1188 ± ·0781 *	− ·0793 ± ·0679 *	+ ·1376 ± ·0633 †
B 13½	—	− ·0370 ± ·1215 *	− ·0615 ± ·0854 *	+ ·1164 ± ·0830 *	+ ·2607 ± ·0746
G 13½	—	+ ·1156 ± ·1060 *	− ·0245 ± ·0756 *	+ ·1459 ± ·0801 *	+ ·1170 ± ·0883 *

+ sign indicates that good teeth and good nutrition are connected.

Mean r, each value being weighted according to its P.E., is ·1154 ± ·0198.

We note that the probable errors of these correlation coefficients are high and especially those of D 1, which is due to the fact that this doctor places such small numbers in the subnormal category. Of these correlation coefficients those marked with an asterisk are less than twice the probable error and are insignificant, those marked with a dagger are doubtful, being within the limits of twice to thrice the probable error, leaving us with possible positive correlation in three cases (B 13, D 4), (B 13, D 5), (B 13½, D 5), the largest of these being five times its probable error. We conclude then that only one doctor provides in all cases a small positive correlation between teeth and nutrition; apart from this, however, we see that there is a small but significant correlation between teeth and nutrition based on the weighted mean.

(ii) *Personal Equation.*

When we try to analyse the differences between the doctors in their distributions of the children in the nutrition groups, a glance at the table on p. 35 shows us that there is not great difference between D 3 and D 4, but that of D 5 and D 1, D 5 is pessimistic and D 1 is optimistic, since D 5 puts most of the cases outside "Normal" into "Subnormal" and D 1 does the reverse. Let us concern ourselves with D 3 and D 4. With nutrition we have no numerical scale and we cannot be certain that the doctors have put the same limits to their "Normal" groups, so we will assume that the discrepancies arise on account of different widths of the normal category being used by the doctors. If x_3 is taken as the width of this category in the scale of nutrition for D 3's distributions and x_4 similarly for D 4's distributions we have these values of the means and standard deviations, the mean being measured from the boundary between the good and normal categories and reckoned positive when on the normal side.

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 3	·30829 x_3	·40237 x_3	·38666 x_3	·45298 x_3	·30475 x_3	·34721 x_3	·47413 x_3	·60801 x_3
D 4	·31925 x_4	·36340 x_4	·38758 x_4	·47585 x_4	·35227 x_4	·36508 x_4	·46598 x_4	·49414 x_4

Now D 3 and D 4 really take samples from the same population, so we have the following system of equations:—

$$
\begin{array}{ll}
\cdot30829\, x_3 = m & \cdot40237\, x_3 = \sigma \\
\cdot31925\, x_4 = m & \cdot36340\, x_4 = \sigma \\
\cdot38666\, x_3 = m' & \cdot45298\, x_3 = \sigma' \\
\cdot38758\, x_4 = m' & \cdot47585\, x_4 = \sigma' \\
\cdot30475\, x_3 = m'' & \cdot34721\, x_3 = \sigma'' \\
\cdot35227\, x_4 = m'' & \cdot36508\, x_4 = \sigma'' \\
\cdot47413\, x_3 = m''' & \cdot60801\, x_3 = \sigma''' \\
\cdot46598\, x_4 = m''' & \cdot49414\, x_4 = \sigma'''.
\end{array}
$$

Where m, m', m'', m''' are the means of the populations from which D 3 and D 4 draw the samples and $\sigma, \sigma', \sigma'', \sigma'''$ are the standard deviations.

From these we can find the best values of the ratios of the quantities $x_3, x_4, m, m', m'', m''', \sigma, \sigma', \sigma'', \sigma'''$ to each other. We have:—

$$\begin{array}{lll} x_3 = 3{\cdot}0087\, m'' & m = {\cdot}9458\, m'' & \sigma = 1{\cdot}1491\, m'' \\ x_4 = 3{\cdot}0238\, m'' & m' = 1{\cdot}1677\, m'' & \sigma' = 1{\cdot}3990\, m'' \\ & m'' = m'' & \sigma'' = 1{\cdot}0728\, m'' \\ & m''' = 1{\cdot}4176\, m'' & \sigma''' = 1{\cdot}6275\, m''. \end{array}$$

If we take on our scale of nutrition $m'' = 1$, we have the width of the normal category given by D 3 and D 4 to be 3·0087 and 3·0238 respectively on this scale. These two values are the same within the probable error, so we see that D 3 and D 4 agree as to the limits of nutrition within which the children are "Normal". Now we will compare the means and standard deviations given by D 3 and D 4 with those of the original population which have just been obtained by the method of least squares, we have:—

	D 3.		Original.		D 4.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
B 13	·9276	1·2106	·9458	1·1491	·9653	1·0988
G 13	1·1634	1·3629	1·1677	1·3990	1·1720	1·4389
B 13½	·9169	1·0447	1·0000	1·0728	1·0652	1·1039
G 13½	1·4265	1·8293	1·4176	1·6275	1·4090	1·4942

The probable errors of the means and standard deviations of the given distributions are:—

	D 3.		D 4.	
	Mean.	S.D.	Mean.	S.D.
B 13	± ·0711	± ·0510	± ·0603	± ·0431
G 1	± ·0856	± ·0591	± ·0778	± ·0556
B 13½	± ·0685	± ·0498	± ·0684	± ·0442
G 13½	± ·1098	± ·0824	± ·0957	± ·0620

Thus the differences between the means and standard deviations in the comparative table above are never more than three times the probable error, and we may consider that the values obtained for x_3 and x_4 are reasonable, and the supposed original distributions with means and standard deviations above are probably the true distributions. We see that there is practically no difference then between D 3 and D 4 in their judgment of nutrition, for the means and standard deviations are sensibly the same and they agree in having the same width for the "Normal" category.

We turn now to the comparison between D 1 and D 5; the means and standard deviations of the distributions given by these doctors are shown in the accompanying table :—

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 5	·27298 x_5	·50505 x_5	·33294 x_5	·62371 x_5	·19829 x_5	·39328 x_5	·32458 x_5	·49200 x_5
D 1	·54803 x_1	·24938 x_1	·63187 x_1	·27391 x_1	—	—	—	—

where x_5 and x_1 are the widths of the "Normal" category as given by the two doctors. We take a supposed original population the age and sex groups of which have means and standard deviations as follows :—

B 13	G 13	B 13½	G 13½
M, Σ	M′, Σ′	M″, Σ″	M‴, Σ‴

The two doctors having drawn samples of these we shall then have :—

$$
\begin{array}{llll}
\cdot 27298\, x_5 = \mathrm{M} & \cdot 33294\, x_5 = \mathrm{M}' & \cdot 19829\, x_5 = \mathrm{M}'' & \cdot 32458\, x_5 = \mathrm{M}''' \\
\cdot 50505\, x_5 = \Sigma & \cdot 62371\, x_5 = \Sigma' & \cdot 39328\, x_5 = \Sigma'' & \cdot 49200\, x_5 = \Sigma''' \\
\cdot 54803\, x_1 = \mathrm{M} & \cdot 63187\, x_1 = \mathrm{M}' & & \\
\cdot 24938\, x_1 = \Sigma & \cdot 27391\, x_1 = \Sigma' & &
\end{array}
$$

from which we obtain the best values of the ratios of the quantities M, M′, M″, M‴, Σ, Σ′, Σ″, Σ‴, x_1, x_5.

These values are given by :—

$$x_1 = \cdot 78485\, x_5$$

$$
\begin{array}{ll}
\mathrm{M} = \cdot 35155\, x_5 & \Sigma = \cdot 35039\, x_5 \\
\mathrm{M}' = \cdot 41443\, x_5 & \Sigma' = \cdot 41934\, x_5 \\
\mathrm{M}'' = \cdot 19829\, x_5 & \Sigma'' = \cdot 39328\, x_5 \\
\mathrm{M}''' = \cdot 32458\, x_5 & \Sigma''' = \cdot 49200\, x_5
\end{array}
$$

If we take the scale of nutrition to be such that $x_5 = 3$,* then we have these values for x_1 and x_5 and for the means and standard deviations of the original population.

$$x_1 = 2 \cdot 3545 \qquad x_5 = 3 \cdot 0$$

B 13.		G 13.		B 13½.		G 13½.	
Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
1·0547	1·0512	1·2433	1·2580	·5949	1·1798	·9737	1·4760

* As is suggested in round numbers by the width of the "Normal" category for D 3 and D 4.

Let us compare these with the given means and standard deviations of D 1 and D 5, they are :—

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 5	·8189	1·5152	·9988	1·8711	·5949	1·1798	·9737	1·4760
D 1	1·2904	·5872	1·4878	·6449	—	—	—	—

We see here great differences between the means and standard deviations of the supposed original population and those of the D 5 and D 1 distributions showing that our assumption of the difference between the widths of the normal categories given by these two doctors is not sufficient to enable us to reduce their data to the same standard. But if we now assume in addition that the two doctors have different standards upon which nutrition is judged, i.e. that "mean nutrition" as judged by D 1 is different from "mean nutrition" as judged by D 5 we can allow for this by assuming that the means given by D 1 must be moved a distance μ to bring them to the means of the original population. We have then these modified equations $\cdot 54803\, x_1 - \mu = M$, $\cdot 63187\, x_1 - \mu = M'$, and the other ten equations being as before, we find :—

$$\begin{array}{llll}
x_1 = \cdot 81607\, x_5 & & \mu = \cdot 17848\, x_5 \\
M = \cdot 27087\, x_5 & & \Sigma = \cdot 35428\, x_5 \\
M' = \cdot 33506\, x_5 & & \Sigma' = \cdot 42362\, x_5 \\
M'' = \cdot 19829\, x_5 & & \Sigma'' = \cdot 39328\, x_5 \\
M''' = \cdot 32458\, x_5 & & \Sigma''' = \cdot 49200\, x_5
\end{array}$$

and assuming again $x_5 = 3$ we have :—

B 13.		G 13.		B 13½.		G 13½.	
Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
·8126	1·0628	1·0052	1·2709	·5949	1·1798	·9737	1·4760

and $x_1 = 2\cdot 4482$, $\mu = \cdot 5354$.

The means and standard deviations of the given distributions are :—

	B 13.		G. 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 5	·8189	1·5152	·9988	1·8711	·5949	1·1798	·9737	1·4760
D 1	·8063	·6105	1·0115	·6706	—	—	—	—

When we compare these with the means and standard deviations of the original distributions we see that although we have allowed for a difference in the means of the two distributions and for a difference in the width of the normal category—the standard deviations are not those of the original population. Consequently our assumptions cannot be the correct assumptions to be made in order to get rid of the differences between D 1 and D 5.

The probable errors of the means and standard deviations of the given distributions are :—

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 5	± ·0712	± ·0565	± ·0908	± ·0815	± ·0673	± ·0629	± ·0928	± ·0689
D 1	± ·1135	± ·0345	± ·1199	± ·0362	—	—	—	—

Let us make the additional assumption that, in order to reduce D 1 to the same standard as D 5, we must spread out the distribution given by D 1, i.e. let us multiply the standard deviations given by D 1 by a factor ν; then we shall have these equations :—

$$
\begin{array}{llll}
\cdot 27298\, x_5 = \mathrm{M} & \cdot 33294\, x_5 = \mathrm{M}' & \cdot 19829\, x_5 = \mathrm{M}'' & \cdot 32458\, x_5 = \mathrm{M}''' \\
\cdot 54803\, x_1 - \mu = \mathrm{M} & \cdot 63187\, x_1 - \mu = \mathrm{M}' & \cdot 39328\, x_5 = \Sigma'' & \cdot 49200\, x_5 = \Sigma''' \\
\cdot 50505\, x_5 = \Sigma & \cdot 24938\, x_1\, \nu = \Sigma & \cdot 62371\, x_5 = \Sigma' & \cdot 27391\, x_1\, \nu = \Sigma'
\end{array}
$$

from which to obtain x_1, x_5, μ, ν, M, M′, M″, M‴, Σ, Σ', Σ'', Σ''', and we have these results :—

$$
\nu = 3\cdot 0257 \qquad x_1 = \cdot 7149\, x_5
$$
$$
\begin{array}{llll}
\mathrm{M} = \cdot 2730\, x_5 & \mathrm{M}' = \cdot 3329\, x_5 & \mathrm{M}'' = \cdot 1983\, x_5 & \mathrm{M}''' = \cdot 3246\, x_5 \\
\Sigma = \cdot 5222\, x_5 & \Sigma' = \cdot 6081\, x_5 & \Sigma'' = \cdot 3933\, x_5 & \Sigma''' = \cdot 4920\, x_5
\end{array}
$$
$$
\text{and } \mu = \cdot 1188\, x_5.
$$

Taking $x_5 = 3\cdot 0$ again, x_1 is now $2\cdot 1446$ and we have these means and standard deviations of the distributions given by D 5 and D 1 modified by μ and ν, and we can compare these with the original populations, means and standard deviations.

	B 13.		G 13.		B 13½.		G 13½.	
	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
D 5 . .	·8189	1·5152	·9988	1·8711	·5949	1·1798	·9737	1·4760
Population	·8190	1·5667	·9988	1·8243	·5949	1·1798	·9737	1·4760
D 1 . .	·8195	1·6204	·9988	1·7774	—	—	—	—

Now we see that the differences between these means and standard deviations are not great compared with the probable errors, so we conclude that compared with D 5 as standard D 1 is different in three ways :—

(*a*) The "mean nutrition" of D 1 is distant from that of D 5 by ·35 units (·1188 x_5) in the direction of better nutrition, i.e. D 1 is optimistic.

(*b*) The range of normal nutrition of D 1 is less than that of D 5,—the ratio of the two being ·7.

(*c*) In spite of (*b*) D 1 has a much greater proportion of cases in the "Normal" category, and has few cases in the extreme categories, and consequently the standard deviation is one-third of the standard deviation of D 5.

When we compare the figures obtained from D 3, D 4 with those from D 5 and D 1 we see that in the former case an assumption of 3 units as the width of the normal category gives us the following means and standard deviations for the original population.

B 13.		G 13.		B 13½.		G 13½.	
Mean.	S.D.	Mean.	S.D.	Mean.	S.D.	Mean.	S.D.
·9458	1·1491	1·1677	1·3990	1·0	1·0728	1·4176	1·6275

and in the latter case the same assumption gives us :—

·8190 1·5667 ·9988 1·8243 ·5949 1·1798 ·9737 1·4760.

We cannot attempt to compare these figures except in a rough manner since they are for two different populations ; but we see that there is some difference between D 5 and D 4, the two standards, although this difference is not as great as it was in the case of the teeth distributions.

We note that in both sets of data the means and standard deviations in the case of boys are less than those for girls and on the average, girls between 12 and 14, have better nutrition than boys of the same age.

V. TEETH AND OTHER FACTORS.

(i) *Condition of Teeth and Cleanliness of Teeth.*

In the annual report for 1911 on School Medical Inspection for our county we find on page 55 that the Senior School Medical Inspector writes: "During the year D 3, D 4 and D 1 recorded various conditions of cleanliness, discoloration, etc., of teeth, in addition to the fact of caries"; and later he defines what is meant by "uncleanness" and "discoloration" in the following words :—

"*Uncleanness.*—By this term is meant a condition in which particles cling to the teeth in such a manner that they could be rubbed off with a brush or the edge of a glass spatula.

"*Discoloration.*—Perfectly sound, clean, and healthy looking teeth fall into three types—(1) the ivory white, (2) the ivory yellow, (3) the nacreous white. These appearances may be marred by discolorations of various sorts, namely, stainings or

pigmentations of the teeth which either cannot be removed at all or not without strong scraping with a sharp edge. In one form of discoloration there is a general darkening or staining of the whole tooth. This is said to indicate death of the tooth pulp . . . it is not in any sense uncleanness."

"Another form of discoloration is where the surface of the teeth show coloured flecks or lines, brown or black. The flecks may coalesce into patches. . . . Sometimes there is a greenish slimy discoloration of the tooth which is said to be due to bacterial colonies. These flecks and lines, like the staining above mentioned should certainly not be taken as evidence of ordinary uncleanness, but they could no doubt be scaled off; and sedulous brushing might prevent their formation."

We therefore proceed to find the correlation between the carious condition of the teeth and the cleanliness of the teeth, for the distributions given by the doctors named above who are referred to in this paper as D 1, D 3, D 4. We note that the other two doctors also return some cases of uncleanness of teeth but these are so few that presumably D 2 and D 5 did not make the careful examination which the other three doctors before the inspection had undertaken to do. We have these results from the fourfold table method, the teeth being grouped as before for the carious condition, and into two groups clean and unclean, + sign meaning that less carious and cleaner teeth go together.

CORRELATION COEFFICIENTS.

	D 1.	D 3.	D 4.
B 13	+ ·2069 ± ·0867 †	+ ·0098 ± ·0683 *	+ ·0392 ± ·0674 *
G 13	+ ·1838 ± ·0765 †	+ ·3318 ± ·0663	+ ·1144 ± ·0671 *
B 13½	—	+ ·0655 ± ·0734 *	+ ·3455 ± ·0666
G 13½	—	+ ·3555 ± ·0643	+ ·2437 ± ·0762

Mean r, found by weighting individual r's according to the P.E.'s, is

$$+ \cdot 1930 \pm \cdot 0223.$$

We note that four of these ten correlation coefficients, the whole of which are positive, are definitely significant, and that the mean correlation for the whole is also significant. This seems to indicate that there is a definite relation of a small amount between the fact of food particles remaining in the mouth and the carious state of the teeth. It is generally understood that before caries in a tooth can set in, a preliminary rotting of the tooth must have followed the chemical changes which take place in the remnants of food lodged in the interstices and crevices of the teeth. This seems to be borne out by the data examined above.

(ii) *Condition of Teeth and Discoloration of Teeth.*

The same three doctors' returns were examined to find the correlation between caries in the teeth and discoloration. The method adopted was like that used in

* $r < 2 \times$ P.E. † r lies between 2 and 3 × P.E.

the last case, the teeth being divided into two groups; normal and discoloured, and the + sign indicates that the good teeth and non-discoloured teeth go together.

CORRELATION COEFFICIENTS.

	D 1.	D 3.	D 4.
B 13	− ·3293 ± ·0829	− ·2785 ± ·0659	+ ·0368 ± ·0693 *
G 13	− ·0680 ± ·0779 *	− ·2353 ± ·0680	− ·0584 ± ·0672 *
B 13½	—	− ·0017 ± ·0739 *	+ ·0898 ± ·0770 *
G 13½	—	− ·1417 ± ·0667 †	+ ·2861 ± ·0780

Mean r, found by weighting individual r's according to the P.E.'s is

− ·0627 ± ·0228.

We see that four of the ten correlation coefficients are just significant, but that only one has any intensity. Also the signs of these r's are some positive, some negative, with the result that the mean r obtained, being less than three times its probable error is of doubtful value, so that we conclude that there is very little correlation between the carious state of the teeth and bad colour, and what correlation there is, seems to indicate that the better teeth are on the average those which are discoloured.

(iii) *Teeth and Nose and Throat.*

The results obtained below were arrived at by the fourfold table method, the state of "nose and throat" being divided into two classes Normal and Not-normal, the latter category including all cases of trouble in the nose or throat, or both. We note that none of the correlation coefficients are sensible and that twelve of them have positive sign and the other six have negative sign, the positive sign indicating that in the data examined the better teeth and normal nose and throat were found together.

TABLE OF CORRELATION COEFFICIENTS.

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	− ·0913 ± ·0878*	− ·1281 ± ·0920*	+ ·0047 ± ·0752*	− ·0886 ± ·0648*	+ ·0669 ± ·0683*
G 13	+ ·0760 ± ·0778*	+ ·1684 ± ·0788†	+ ·0564 ± ·0784*	+ ·0196 ± ·0630*	+ ·0094 ± ·0676*
B 13½	—	+ ·0633 ± ·0677*	− ·0263 ± ·0823*	− ·0674 ± ·0665*	+ ·0797 ± ·0805*
G 13½	—	+ ·0378 ± ·0644*	+ ·0343 ± ·0745*	− ·0914 ± ·0705*	+ ·0221 ± ·0930*

Mean r, found by weighting individual r's according to the P.E.'s, is

+ ·0088 ± ·0174, which is not significant.

(iv) *Teeth and Cleanliness of the Body and Hair.*

We do not suppose that there is any direct association between the condition of teeth and cleanliness of the body, but we can regard cleanliness as a measure

* $r < 2 \times$ P.E. † r lies between 2 and 3 × P.E.

of the general condition of the home. The fourfold table method was used to obtain the accompanying values for the correlation coefficient, the division of "Cleanliness" being into two classes, Normal and Not-normal, the latter including all those cases which are given as having dirty hair or dirty body, or both, and the division of teeth into two classes is the same as that used throughout the paper. We may observe that eight of the correlation coefficients have positive signs and the other ten have negative signs, the positive sign indicating that the better teeth and cleaner children are found together, also we note that one coefficient only is sensible, being slightly more than three times its probable error.

TABLE OF CORRELATION COEFFICIENTS.

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	− ·1317 ± ·0888*	− ·2078 ± ·0681	− ·1146 ± ·1070*	− ·1552 ± ·0860*	− ·0054 ± ·1062*
G 13	− ·0606 ± ·0821*	− ·0213 ± ·0630*	+ ·0425 ± ·0739*	− ·1001 ± ·0600*	+ ·2104 ± ·0778†
B 13½	—	+ ·1681 ± ·0781†	+ ·0472 ± ·0702*	+ ·1915 ± ·0884†	+ ·1182 ± ·0729*
G 13½	—	− ·0970 ± ·0835*	+ ·0319 ± ·0715*	− ·0039 ± ·0699*	+ ·0754 ± ·0638*

Mean r, obtained by weighting individual r's according to the P.E.'s is

$$- \cdot 0003 \pm \cdot 0179, \text{ which is not significant.}$$

Considering cleanliness of the body and hair as some reflection on the home conditions of the child, we see that there is no sensible correlation between the carious state of the teeth and the home conditions as judged from the cleanliness of the child.

(v) *Teeth and Anæmia.*

The children were divided into two classes for anæmia, normal and anæmic, and the fourfold table method was used. Again we see that only one of the correlation coefficients is sensible, being three times its probable error and that fourteen have positive sign and four negative sign, the positive sign indicating that better teeth and normal state of the blood are found together. The mean r is found to be positive and small but significant, being five times its probable error.

TABLE OF CORRELATION COEFFICIENTS.

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	+ ·0268 ± ·1127*	+ ·1719 ± ·0910*	− ·0491 ± ·1161*	+ ·1490 ± ·0773*	+ ·1061 ± ·1227*
G 13	+ ·0238 ± ·0866*	+ ·2621 ± ·0835	+ ·2013 ± ·0858†	+ ·0173 ± ·0729*	− ·0669 ± ·0828*
B 13½	—	− ·0226 ± ·1157*	− ·0939 ± ·1434*	+ ·0877 ± ·0871*	+ ·1548 ± ·1046*
G 13½	—	+ ·1385 ± ·1110*	+ ·2518 ± ·0901†	+ ·1287 ± ·0863*	+ ·0529 ± ·0720*

* $r < \cdot 2 \times$ P.E. † r lies between 2 and 3 × P.E.

Mean r found by weighting individual r's according to the probable errors is $+ \cdot 1027 \pm \cdot 0217$, which is significant, but of so small an intensity as to be of little prediction value.

(vi) *Teeth and Employment of Father.*

The father's employment was graded into six classes, in order that they should represent a scale of degree of comfort in the home; the classes include the following:—

A. Farmers, shopkeepers, clerks and generally the aristocracy of labour.

B. Men of skilled trades, carpenters, etc., and the artisans of the iron works.

C. Carters, railwaymen and other transport workers; and those in service.

D. Miners and colliery workers.

E. Factory hands.

F. General labourers and farm labourers.

The division of teeth being into two classes, as before, the biserial-η method was used to find the correlation between teeth and father's employment. The sign given to the correlation ratios thus obtained was found by considering each table as a fourfold table, and the sign which would be given to the correlation coefficient, as found from such a table, was given to the correlation ratio found as above. The positive sign indicates that the better teeth are found in children whose parents are higher up the social scale. It will be seen that seven of these correlation ratios have the positive sign and eleven have the negative sign. Of these correlation ratios only two are found to be significant, on being compared with the mean of the η's which can arise when there is no real correlation between the two characters under discussion.

TABLE OF CORRELATION RATIOS (BISERIAL-η).

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	+ ·2011 ± ·0568	+ ·3199 ± ·0548	− ·2084 ± ·0423	+ ·3842 ± ·0354 *	+ ·1419 ± ·0370
G 13	− ·2411 ± ·0498	− ·3156 ± ·0531	− ·1391 ± ·0455	+ ·1405 ± ·0392	− ·1905 ± ·0377
B 13½	—	− ·2963 ± ·0417*	+ ·2060 ± ·0463	− ·1503 ± ·0441	− ·2483 ± ·0436
G 13½	—	− ·2038 ± ·0416	+ ·2545 ± ·0427	− ·2271 ± ·0428	− ·1867 ± ·0485

The two correlation ratios marked with an asterisk are significant, when compared with the mean η, obtained on the assumption that there is no correlation ("Biometrika," VIII, 254). The weighted mean of these correlation ratios is $- \cdot 0337 \pm \cdot 0103$; which, if significant, is too small to be of any value. Thus from the data examined we find no appreciable correlation between the carious state of the teeth and the social status of the child as judged by the father's employment.

SUMMARY OF CONCLUSIONS AS TO TEETH.

The table below shows the mean correlation coefficients or correlation ratios obtained for the whole county in two parts, one containing those which correlate teeth and some character which might give an indication of the health of the child, the other containing those which correlate teeth and some character which might give an indication of the home conditions of the child.

Correlation of condition of teeth with :—

Weight	+ ·0381 ± ·0136
Nutrition	+ ·1154 ± ·0198
Anemia	+ ·1027 ± ·0217
Nose and throat	+ ·0088 ± ·0174
Cleanliness of body, etc.	– ·0003 ± ·0179
Father's employment	– ·0337 ± ·0103

From this table we see that there is very little correlation between teeth and the health of the child as judged by its weight, its nutrition, its being anæmic or not, and the condition of its nose and throat.

On the whole, we can find nowhere any very high degree of correlation between bad teeth and any other characters examined; in many cases the signs of the individual correlation coefficients may be either positive or negative, and the mean r, in some of the cases, becomes insensible.

We realise that the data collected by the Medical Inspectors which have been used here were not originally collected with a view to its undergoing statistical treatment, and that for the purposes of medical inspection, to return a child as having " several " teeth carious would be sufficient for the purpose of the examination, which was that the child should if necessary undergo dental treatment. But if such data could be collected with the two ends in view—first, that they should be used for drawing attention to especially bad cases and so helping to preserve the standard of health, and secondly for analysis by the statistician, very little extra trouble would be entailed and its value from the standpoint of social hygiene would rise beyond all proportion to the extra trouble involved.

VI. ASSOCIATION OF OTHER FACTORS.

We now proceed to some additional associations which can be investigated from our material.

(i) *Weight and Father's Employment.*

The tables were examined to find out if there was any relation between the health of the child (judging this by his or her weight) and the home conditions or social status as judged by the father's employment. The same grades of employ-

ment were used as before, and the following correlation ratios were obtained, the positive sign indicating that the heavier children were found in better homes, this being judged by the better type of employment. Only two of these correlation ratios are negative ; and six of them are significant after being compared with the mean η, as above. The sign was given by considering what sign a correlation coefficient would have, when found by the biserial-r method. The weighted mean η is significant, being + ·1640 ± ·0106, but again is of no great intensity ; it indicates that, on the whole, for the data examined heavier children are found in better homes.

Two diagrams given below show the means and the regression line for two of the cases where η is significant, viz., B 13, D 5 and G $13\frac{1}{2}$, D 2 (these being chosen because the total frequencies involved were large and the probable errors were small). The breadths of the categories of employment were obtained on the as-

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER. B 13 D5

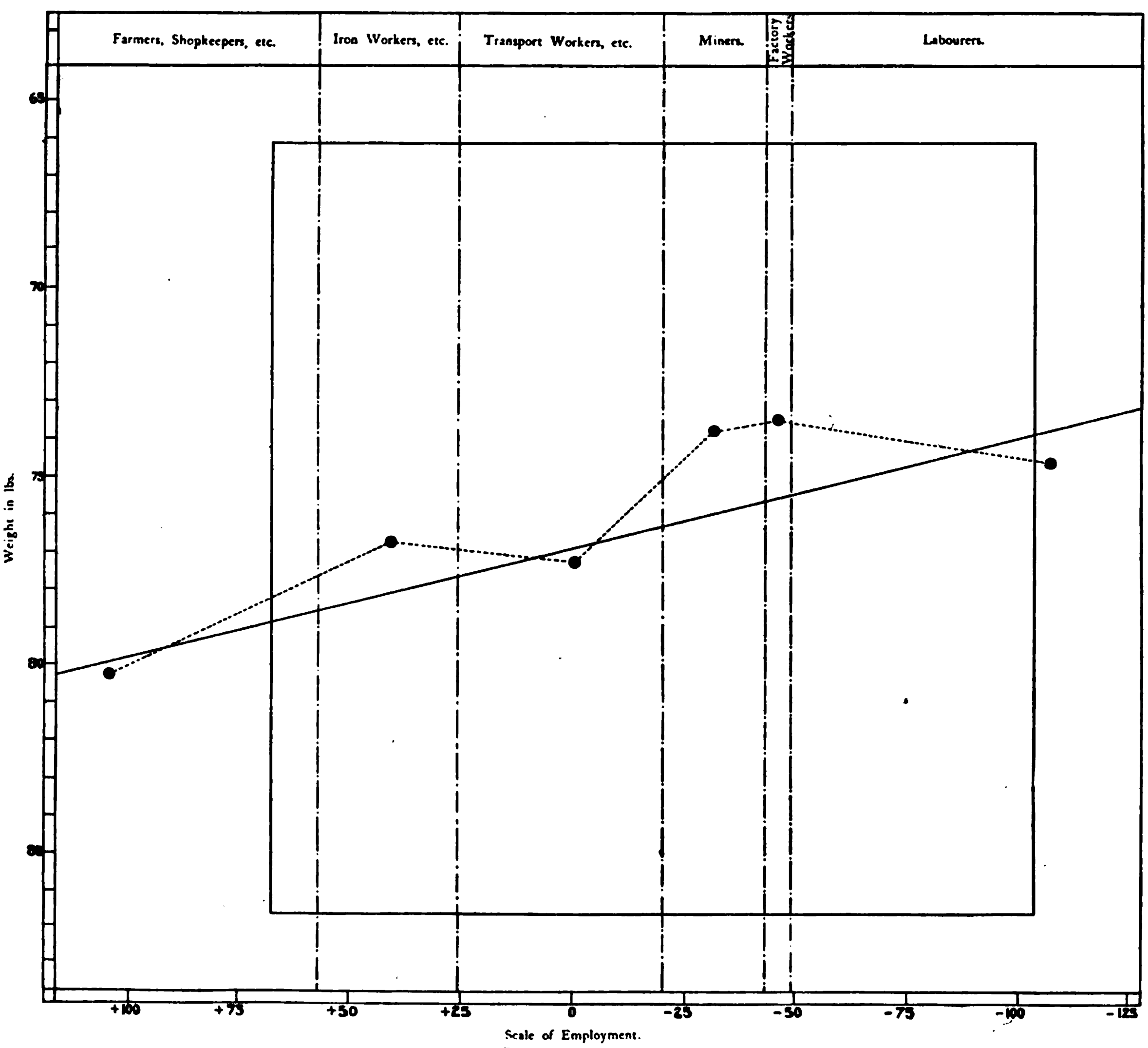

DIAGRAM II.

sumption that the distribution of employment is Gaussian, and the scale of employment shown was obtained by considering the whole population of fathers as one distribution for employment and assuming that the combined breadth of the B, C, D categories was 100 units. Also, the zero from which the employment scale is measured is the mean of the employment distribution of the whole population of fathers.

TABLE OF CORRELATION RATIO η.

	D 1.	D 2.	D 3.	D 4.	D 5.
B 13	+ ·3093 ± ·0582	+ ·5414 ± ·0562*	+ ·1650 ± ·0443	+ ·2163 ± ·0421	+ ·2423 ± ·0363*
G 13	+ ·2575 ± ·0547	+ ·2390 ± ·0801	+ ·2592 ± ·0447	+ ·1902 ± ·0410	+ ·1367 ± ·0389
B 13½	—	+ ·2689 ± ·0433	+ ·1643 ± ·0477	− ·3366 ± ·0407*	+ ·1963 ± ·0462
G 13½	—	+ ·3056 ± ·0401*	+ ·1787 ± ·0465	− ·3278 ± ·0413*	+ ·3397 ± ·0456*

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER. G 13½ D2

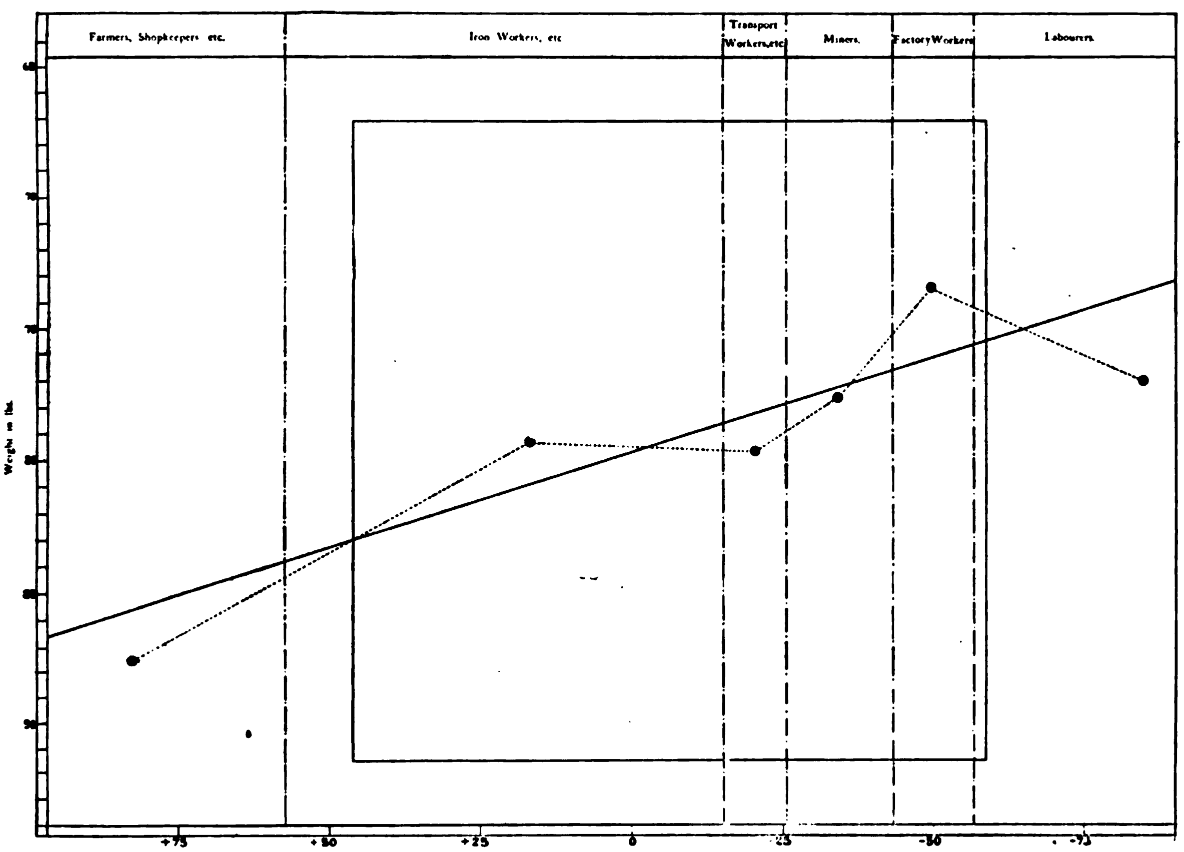

Diagram III.

We also append a diagram showing the distribution of employment of fathers (i) for the whole population; (ii) for the rural population, judging this by the children who go to the rural schools; (iii) for the urban population, judging this by the children who go to the town schools.

* Significant η's.

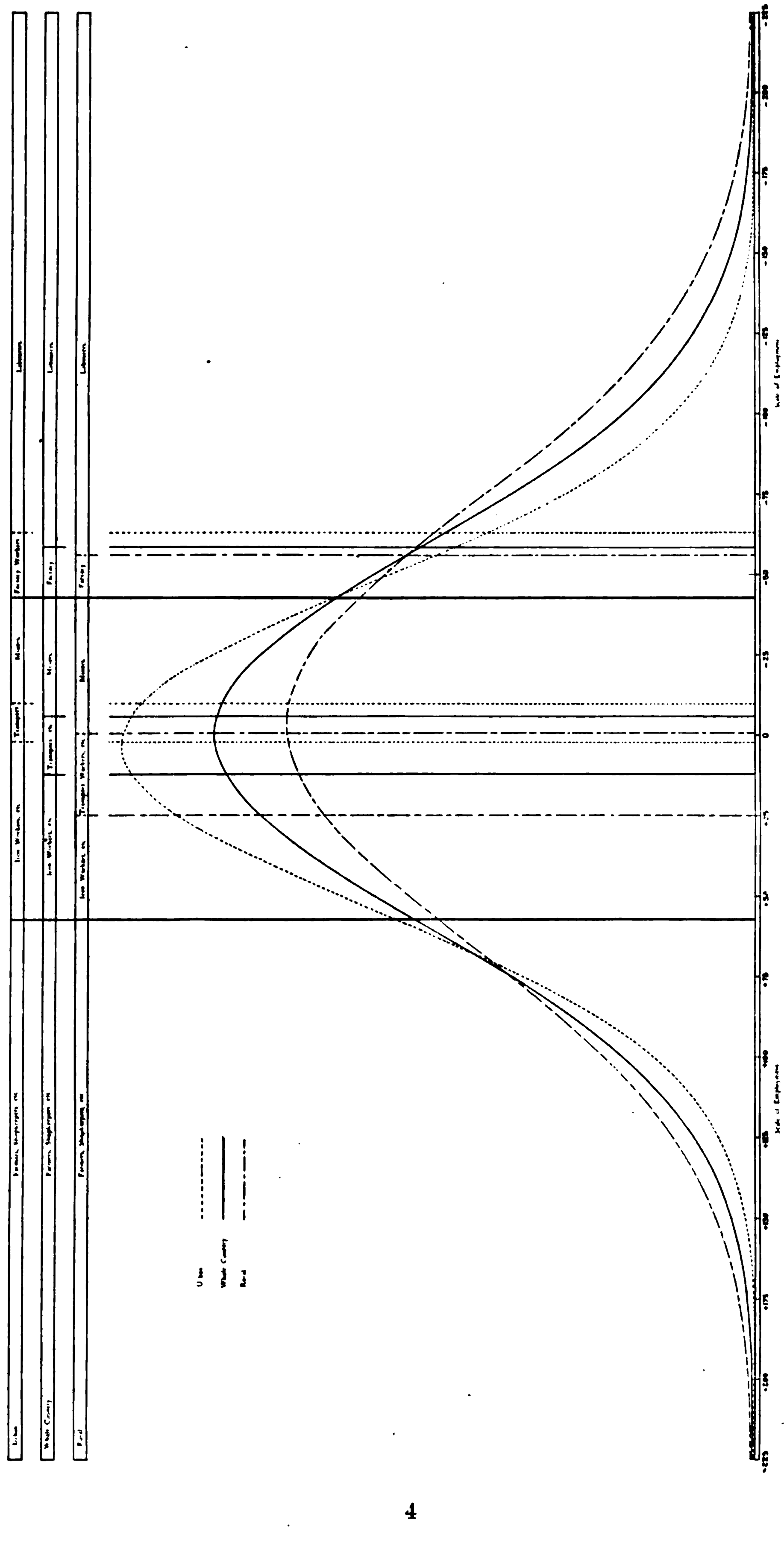

DIAGRAM IV.

The curves are reduced so that the total area of each is the same; the width of the combined categories B, C, D is the same for each distribution. It will be seen that the standard deviations are different, but that the means are very similar; that the distribution of employment in the country is much more spread out than in the town, that is to say, the fathers in the towns who send their children to the schools examined by the School Medical Officers tend to be more of the same grade of employment than the fathers in the rural districts who send their children to the local schools. The following figures are obtained from the employment distributions and from these the diagram was drawn :—

WHOLE POPULATION (divided into 6 classes).

	A.	B.	C.	D.	E.	F.	Total.
	590	875	421	786	255	568	3495
Distance from mean to division line between classes, divided by σ	$-\cdot95887$	$-\cdot20402$	$+\cdot09950$	$+\cdot72092$	$+\cdot98413$		

Assuming width of B, C, D categories combined is 100 units on the scale of employment, we have $\frac{100}{\sigma} = 1\cdot67979$; $\sigma = 59\cdot531$ units.

COUNTRY POPULATION.

	A.	B.	C.	D.	E.	F.	Total.
	356	284	270	434	115	412	1871
Distance from mean to division line between classes, divided by σ	$-\cdot87690$	$-\cdot40684$	$-\cdot03417$	$+\cdot57790$	$+\cdot77151$		

Assuming width of B, C, D categories combined to be 100 units on the scale of employment, we have $\frac{100}{\sigma} = 1\cdot45480$; $\sigma = 68\cdot738$ units.

TOWN POPULATION.

	A.	B.	C.	D.	E.	F.	Total.
	234	591	151	352	140	156	1624
Distance from mean to division line between classes, divided by σ	$-1\cdot06214$	$+\cdot02007$	$+\cdot25590$	$+\cdot90677$	$+1\cdot30436$		

Assuming width of B, C, D categories combined to be 100 units on the scale of employment, we have $\frac{100}{\sigma} = 1\cdot96891$; $\sigma = 50\cdot790$ units.

Taking the mean of the whole population distribution as zero, we have these figures in units of employment.

Distance from zero to division line between	A, B.	B, C.	C, D.	D, E.	E, F.	Mean.	S, D.
Whole population	− 57·08	− 12·15	+ 5·92	+ 42·92	+ 58·59	0	59·531
Country	− 57·08	− 24·77	+ 0·84	+ 42·92	+ 56·23	+ 3·19	68·738
Town	− 57·08	− 2·12	+ 9·86	+ 42·92	+ 63·11	− 3·14	50·790

(ii) *Nutrition and Weight.*

If we form tables showing the distribution of weight for the two classes of nutrition, subnormal and normal, and find the correlation coefficients by the biserial method, we have the following results :—

	D 3.	D 4.	D 5.	D 2.
B 13 . .	+ ·6870 ± ·0403	+ ·6034 ± ·0465	+ ·6910 ± ·0309	+ ·6229 ± ·1351
G 13 . .	+ ·7290 ± ·0407	+ ·6111 ± ·0422	+ ·7082 ± ·0308	+ ·3122 ± ·1470*
B 13½ . .	+ ·6854 ± ·0446	+ ·5947 ± ·0478	+ ·6158 ± ·0422	+ ·1620 ± ·0962*
G 13½ . .	+ ·6439 ± ·0451	+ ·6499 ± ·0483	+ ·6532 ± ·0470	+ ·5248 ± ·0728

The positive sign indicating that the children of better nutrition are heavier.

It will be seen that D 3, D 4 and D 5 all give high correlation coefficients, but that the two marked with an asterisk of D 2's cases are not significant or are doubtful: the large probable errors are due to D 2 having such small numbers in the subnormal category.

The weighted mean of these correlation coefficients is ·6514 ± ·0114, which is of quite considerable intensity, but it might be suggested that the medical judgment as to nutrition, if not actually based on weight, was partly based on size and plumpness for a given age which would be closely related to weight.

(iii) *Nutrition and Anæmia.*

The data were examined for any possible association between nutrition and anæmia. The fourfold table method was used, but the results for D 1's groups are not shown, as the numbers of children in the subnutrition category was only two in each class B 13 and G 13½. The numbers also involved in the D 2 groups were small numbers in the subnormal category, giving large probable errors to the correlation coefficients. We have these results:—

TABLE OF CORRELATION COEFFICIENTS.

	D 2.	D 3.	D 4.	D 5.
B 13	+ ·1140 ± ·1715*	+ ·4578 ± ·1079	+ ·4267 ± ·0786	+ ·2490 ± ·0880†
G 13	+ ·0658 ± ·1437*	+ ·2650 ± ·0955†	+ ·1664 ± ·0802†	+ ·2472 ± ·0839†
B 13½	+ ·0738 ± ·1455*	+ ·3142 ± ·1523†	+ ·1732 ± ·1017*	+ ·1798 ± ·1078*
G 13½	+ ·3183 ± ·1125†	+ ·2183 ± ·1014†	+ ·3465 ± ·0929	+ ·3430 ± ·1030

The positive sign indicates that good nutrition and normal (not anæmic) children are found together. We see that although their probable errors are large, all these coefficients are positive; taken as a whole series they are all, except in the majority of D 2's groups, of the order of ·2 to ·3, and this leads us to believe that there is quite definite association between these two characters in the data examined; the mean for the whole series of correlation coefficients is + ·2659 ± ·0256. It is, however, again probable that the judgment of anæmia by *appearance* was a contributory factor in the judgment of nutrition.

VII. CONCLUSIONS.

The conclusions we can draw from this paper are of two kinds which may be classed as positive and negative.

(*a*) We see from the data examined that the degrees of association between the state of caries in the teeth of children of ages 12 to 14 years and their general health and the home environment are very slight, being roughly about 0·1 in the scale of the correlation coefficient, where the range is from 0 to 1, 0 being equivalent to absolute independence and 1 being equivalent to perfect association between two characters. We are the more impressed with the small degree of correlation between the characters under consideration, when we consider the place such correlation occupies in the scale of association, and compare the numerical value of the relationship with other numbers expressing associations between characters. For instance, the degree of relationship between parent and child has been found for many physical characters to be represented by 0·5 in our scale, which shows a much higher degree of association than that found in this paper to exist between teeth and general health and teeth and home conditions. Such considerations suggest that it would be of interest to examine if any association exists between the state of the parents' teeth and those of the children, and if such an examination gave a result of the same order as those obtained for other physical characters, i.e. about ·5, we should be justified in asserting that on the average bad teeth in a child are due more to bad teeth in the stock than to ill-attention during growth.

(*b*) The School Medical Inspections instituted by the Board of Education are primarily for the purpose of finding out the needs of our children and bringing relief where it is necessary. A statistical inquiry into the data furnished by such an inspection and the resultant comparisons to be made between the sexes, between different ages, between different districts, etc., are of secondary importance, but such inquiry is intended in the original scheme. We have seen, however, in the Blankshire data that the standards used by the doctors in diagnosing the state of nutrition, anæmia, etc., are not always the same and also that there is considerable divergence in the methods of teeth inspection, where one might expect as concise results as one obtains in measurements of height and weight. Thus the kind of treatment which has been used in this paper is necessary before the data can be properly analysed, and even with such treatment the results are not satisfactory, seeing that assumptions of one kind and another are everywhere necessary. But whereas the statistician examines his data to see if divergencies exist amongst the inspectors before attempting to compare divergencies amongst those inspected, the untrained analyser of such records will assume that there are no differences in the standards upon which the judgment of such characters as nutrition are based, and present results which often may have no meaning, because the differences between the standards used will sometimes emphasise and sometimes

counteract differences which may exist in the populations from which the doctors sample. In a medical inspection of children in a large town, N., two doctors worked together; one examined all the boys, the other all the girls, and the one doctor showed results which indicated that the boys of this town were fine well-nourished children, whereas the other doctor's results showed a population of girls, the sisters of the boys examined by the other doctor, who were poor, weak, ill-nourished specimens. The two doctors had not originally compared their methods of judging nutrition by both examining separately the same sample of children.

This paper has been published with the view of emphasising the national importance of standardising the judgments of the School Medical Officers of different localities. Without this standardisation it is impossible to judge of the relative welfare of the school population in rural and in urban districts, or in urban districts with different dominant manufactures. It is not too strong a judgment—sweeping as it may seem to be—to assert that at the present day all conclusions drawn from the reports of the chief School Medical Officers are of no value for comparative purposes. This is not those officers' fault; their work is so arduous that they are bound to do much of it by deputy, and the present statistical training provided for candidates for diplomas of public health is so inadequate that many assistant School Medical Officers have not the least idea of the importance of standardisation, and even if they had, and could aim at it among their colleagues in one locality, there is at present no provision, whatever, made for a national standardisation in school inspection. The divergencies indicated in this paper would disappear with a proper local standardisation, but we should be left with what is of still greater importance from the national standpoint: the intra-district want of standardisation would disappear, but the inter-district divergencies would remain to confuse all national administrators. This problem of national standards—quite as important as those of weight and length—is one so urgent that we may well hope that the youngest of all the ministries is not yet too old to carry through some adequate measure of reform, while it has youth and freshness for this necessary but undoubtedly difficult task.

APPENDIX.—NUMERICAL TABLES.

The following tables give the data upon which the discussions in this memoir are based. It has been considered desirable to publish them as they will bring more clearly before the statistical reader the difficulties which arise in the treatment of the material.

I. NUMBER OF CARIOUS TEETH AND WEIGHT.

Boys 13.

Weight in lb.

No. of Carious Teeth	D 1. 0	1	2	3	4	5	6	7	Sev.	Total.	D 2. 0	1	2	3	4	5	6	7	8	Sev.	Total.
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
$55\frac{7}{8}$- $58\frac{7}{8}$	—	3	—	1	—	—	—	—	—	4	1	—	1	1	—	—	—	—	—	—	3
$58\frac{7}{8}$- $61\frac{7}{8}$	—	—	4	—	—	—	—	—	1	5	1	—	1	—	—	—	1	—	—	—	3
$61\frac{7}{8}$- $64\frac{7}{8}$	—	1	5	3	1	—	1.	—	—	11	—	3	4	—	1	—	1	—	—	—	9
$64\frac{7}{8}$- $67\frac{7}{8}$	2	—	2	2	1	1	1	—	—	9	—	3	—	—	—	1	2	—	—	1	7
$67\frac{7}{8}$- $70\frac{7}{8}$	1	3	4	1	3	1	—	1	1	15	2	2	3	1	1	2	1	—	—	—	12
$70\frac{7}{8}$- $73\frac{7}{8}$	1	2	4	5	3	—	—	—	1	16	—	—	4	—	2	—	1	—	—	—	7
$73\frac{7}{8}$- $76\frac{7}{8}$	3	5	2	1	2	—	1	—	—	14	—	2	3	3	3	3	—	—	—	—	14
$76\frac{7}{8}$- $79\frac{7}{8}$	1	3	1	2	1	1	—	—	1	10	—	4	7	2	I	—	—	—	—	—	14
$79\frac{7}{8}$- $82\frac{7}{8}$	3	1	—	4	3	—	—	—	1.	12	1	1	1	2	—	—	—	—	—	—	5
$82\frac{7}{8}$- $85\frac{7}{8}$	1	1	2	1	—	1	—	—	2	8	2	—	2	1	—	—	—	—	1	—	6
$85\frac{7}{8}$- $88\frac{7}{8}$	2	2	1	1	—	—	—	—	1	7	—	1	1	1	1	—	—	—	—	—	4
$88\frac{7}{8}$- $91\frac{7}{8}$	—	—	1	1	—	—	—	—	1	3	1	1	1	—	—	—	—	—	—	—	3
$91\frac{7}{8}$- $94\frac{7}{8}$	—	2	—	—	—	—	—	—	—	2	—	1	—	—	1	—	—	—	—	—	2
$94\frac{7}{8}$- $97\frac{7}{8}$	2	—	3	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—
$97\frac{7}{8}$-$100\frac{7}{8}$	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Totals .	17	23	29	22	14	4	3	1	9	122	8	18	29	11	10	6	6	—	1	1	90

Weight in lb.

No. of Carious Teeth	D 3. 0.	1.	2.	3.	4.	5.	Sev.	Total.
$40\frac{7}{8}$- $43\frac{7}{8}$	—	—	—	—	—	—	—	—
$43\frac{7}{8}$- $46\frac{7}{8}$	—	—	—	—	—	—	—	—
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	1	—	1	—	—	2
$55\frac{7}{8}$- $58\frac{7}{8}$	3	1	1	—	1	—	1	7
$58\frac{7}{8}$- $61\frac{7}{8}$	2	—	3	1	1	—	1	8
$61\frac{7}{8}$- $64\frac{7}{8}$	—	5	4	4	—	1	2	16
$64\frac{7}{8}$- $67\frac{7}{8}$	4	2	16	3	1	—	1	27
$67\frac{7}{8}$- $70\frac{7}{8}$	4	3	9	4	3	—	—	23
$70\frac{7}{8}$- $63\frac{7}{8}$	8	4	9	6	2	—	2	31
$73\frac{7}{8}$- $76\frac{7}{8}$	6	5	14	7	1	—	1	34
$76\frac{7}{8}$- $79\frac{7}{8}$	8	—	9	2	—	—	1	20
$79\frac{7}{8}$- $82\frac{7}{8}$	7	3	6	3	2	—	—	21
$82\frac{7}{8}$- $85\frac{7}{8}$	4	6	3	2	1	—	1	17
$85\frac{7}{8}$- $88\frac{7}{8}$	1	1	3	2	1	—	—	8
$88\frac{7}{8}$- $91\frac{7}{8}$	3	2	4	1	1	—	—	11
$91\frac{7}{8}$- $94\frac{7}{8}$	2	1	1	—	—	—	—	4
$94\frac{7}{8}$- $97\frac{7}{8}$	—	—	2	—	—	—	—	2
$97\frac{7}{8}$-$100\frac{7}{8}$	1	1	2	—	—	—	—	4
$100\frac{7}{8}$-$103\frac{7}{8}$	—	—	—	1	1	—	—	2
$103\frac{7}{8}$-$106\frac{7}{8}$	1	—	3	—	—	—	—	4
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	—	—	1	—	—	1
$109\frac{7}{8}$-$112\frac{7}{8}$	—	—	—	—	—	—	—	—
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	—	—
Totals .	54	34	90	36	17	1	10	242

No. of Carious Teeth	D 4. 0.	1.	2.	3.	4.	5.	6.	7.	8.	Total.
$40\frac{7}{8}$- $43\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$43\frac{7}{8}$- $46\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	1	1	—	1	—	—	—	—	3
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	—	—	1	—	—	—	—	1
$55\frac{7}{8}$- $58\frac{7}{8}$	1	—	1	2	1	—	—	1	—	6
$58\frac{7}{8}$- $61\frac{7}{8}$	1	1	8	—	1	—	—	—	—	11
$61\frac{7}{8}$- $64\frac{7}{8}$	3	3	3	3	1	—	—	—	—	13
$64\frac{7}{8}$- $67\frac{7}{8}$	6	10	4	5	3	4	1	—	—	33
$67\frac{7}{8}$- $70\frac{7}{8}$	8	8	9	3	4	1	—	—	—	33
$70\frac{7}{8}$- $63\frac{7}{8}$	6	9	14	7	2	3	—	—	1	42
$73\frac{7}{8}$- $76\frac{7}{8}$	4	7	11	4	2	—	1	—	—	29
$76\frac{7}{8}$- $79\frac{7}{8}$	6	6	5	4	1	1	1	—	—	24
$79\frac{7}{8}$- $82\frac{7}{8}$	7	4	4	2	1	2	—	—	—	20
$82\frac{7}{8}$- $85\frac{7}{8}$	3	6	4	2	2	—	—	—	—	17
$85\frac{7}{8}$- $88\frac{7}{8}$	5	5	2	—	1	—	—	—	—	13
$88\frac{7}{8}$- $91\frac{7}{8}$	1	2	1	2	1	—	—	—	—	7
$91\frac{7}{8}$- $94\frac{7}{8}$	1	—	1	—	—	—	—	—	—	2
$94\frac{7}{8}$- $97\frac{7}{8}$	—	1	—	—	—	—	—	—	—	1
$97\frac{7}{8}$-$100\frac{7}{8}$	—	—	1	1	—	—	—	—	—	2
$100\frac{7}{8}$-$103\frac{7}{8}$	—	1	1	—	1	—	—	—	—	3
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$109\frac{7}{8}$-$112\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
Totals .	52	64	70	35	23	11	3	1	1	260

No. of Carious Teeth	D 5. 0.	1.	2.	3.	4.	5.	11.	Sev.	Total.
$40\frac{7}{8}$- $43\frac{7}{8}$	—	—	—	—	—	—	—	1	1
$43\frac{7}{8}$- $46\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	—	—	—	—	—	2	2
$55\frac{7}{8}$- $58\frac{7}{8}$	—	—	—	—	—	—	—	2	2
$58\frac{7}{8}$- $61\frac{7}{8}$	1	—	—	—	—	—	—	8	9
$61\frac{7}{8}$- $64\frac{7}{8}$	4	2	—	—	—	—	—	18	24
$64\frac{7}{8}$- $67\frac{7}{8}$	8	2	4	—	—	—	—	20	34
$67\frac{7}{8}$- $70\frac{7}{8}$	8	3	1	1	—	1	—	22	36
$70\frac{7}{8}$- $63\frac{7}{8}$	7	3	1	1	—	—	—	36	48
$73\frac{7}{8}$- $76\frac{7}{8}$	7	4	3	—	—	—	1	20	35
$76\frac{7}{8}$- $79\frac{7}{8}$	6	4	3	1	—	—	—	18	32
$79\frac{7}{8}$- $82\frac{7}{8}$	6	4	5	1	—	—	—	24	40
$82\frac{7}{8}$- $85\frac{7}{8}$	3	5	1	—	—	—	—	17	26
$85\frac{7}{8}$- $88\frac{7}{8}$	6	1	—	1	—	—	—	7	15
$88\frac{7}{8}$- $91\frac{7}{8}$	3	2	4	—	—	—	—	6	15
$91\frac{7}{8}$- $94\frac{7}{8}$	1	3	2	1	—	—	—	5	12
$94\frac{7}{8}$- $97\frac{7}{8}$	—	—	—	—	—	—	—	3	3
$97\frac{7}{8}$-$100\frac{7}{8}$	—	—	1	—	—	—	—	3	4
$100\frac{7}{8}$-$103\frac{7}{8}$	—	1	—	—	—	—	—	2	3
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	—	—	—	1	1
$106\frac{7}{8}$-$109\frac{7}{8}$	1	—	—	—	—	—	—	—	1
$109\frac{7}{8}$-$112\frac{7}{8}$	1	—	—	—	—	—	—	—	1
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	1	—	—	—	—	—	—	1
Totals .	62	35	25	6	—	1	1	215	345

NUMBER OF CARIOUS TEETH AND WEIGHT.

Girls 13.

D 1.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	5.	6.	Sev.	Total.
$49\frac{7}{8}$-$52\frac{7}{8}$	—	1	—	1	—	—	—	1	3
$52\frac{7}{8}$-$55\frac{7}{8}$	1	—	—	—	—	—	—	—	1
$55\frac{7}{8}$-$58\frac{7}{8}$	1	2	1	—	1	—	—	—	5
$58\frac{7}{8}$-$61\frac{7}{8}$	1	1	1	1	2	—	—	1	7
$61\frac{7}{8}$-$64\frac{7}{8}$	—	3	3	1	1	—	1	1	10
$64\frac{7}{8}$-$67\frac{7}{8}$	4	7	2	1	1	1	—	—	16
$67\frac{7}{8}$-$70\frac{7}{8}$	1	1	6	1	2	1	—	1	13
$70\frac{7}{8}$-$73\frac{7}{8}$	—	4	2	1	2	1	—	2	12
$73\frac{7}{8}$-$76\frac{7}{8}$	2	2	5	1	3	—	—	—	13
$76\frac{7}{8}$-$79\frac{7}{8}$	1	—	6	—	2	1	—	—	10
$79\frac{7}{8}$-$82\frac{7}{8}$	3	2	2	1	—	3	—	1	12
$82\frac{7}{8}$-$85\frac{7}{8}$	3	2	5	2	1	—	—	—	13
$85\frac{7}{8}$-$88\frac{7}{8}$	4	1	3	—	1	—	—	—	9
$88\frac{7}{8}$-$91\frac{7}{8}$	1	1	2	4	1	—	—	—	9
$91\frac{7}{8}$-$94\frac{7}{8}$	1	1	2	1	—	—	—	—	5
$94\frac{7}{8}$-$97\frac{7}{8}$	2	1	3	—	—	—	—	—	6
$97\frac{7}{8}$-$100\frac{7}{8}$	—	1	1	1	—	—	—	—	3
$100\frac{7}{8}$-$103\frac{7}{8}$	—	1	2	—	—	—	—	—	3
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	1	—	—	—	1
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	1	—	—	—	—	—	1
$109\frac{7}{8}$-$112\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	1	—	—	—	—	—	—	1
Totals .	25	32	47	16	18	7	1	7	153

D 2.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Total.
$49\frac{7}{8}$-$52\frac{7}{8}$	1	—	—	—	—	—	—	—	—	—	1
$52\frac{7}{8}$-$55\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—
$55\frac{7}{8}$-$58\frac{7}{8}$	—	—	—	1	—	—	—	—	—	—	1
$58\frac{7}{8}$-$61\frac{7}{8}$	—	—	—	1	1	—	—	—	1	—	3
$61\frac{7}{8}$-$64\frac{7}{8}$	2	—	3	2	—	—	—	—	—	1	8
$64\frac{7}{8}$-$67\frac{7}{8}$	1	—	—	—	1	—	—	—	—	—	2
$67\frac{7}{8}$-$70\frac{7}{8}$	—	1	7	4	1	1	—	—	—	—	14
$70\frac{7}{8}$-$73\frac{7}{8}$	1	1	2	2	—	—	—	1	—	—	7
$73\frac{7}{8}$-$76\frac{7}{8}$	2	1	2	—	3	—	—	—	—	1	9
$76\frac{7}{8}$-$79\frac{7}{8}$	—	1	2	1	1	—	—	—	—	1	6
$79\frac{7}{8}$-$82\frac{7}{8}$	6	—	—	2	—	1	—	—	—	1	10
$82\frac{7}{8}$-$85\frac{7}{8}$	2	5	—	1	—	1	—	—	—	—	9
$85\frac{7}{8}$-$88\frac{7}{8}$	1	—	—	1	—	—	—	—	—	—	2
$88\frac{7}{8}$-$91\frac{7}{8}$	3	1	1	1	1	—	—	—	—	—	7
$91\frac{7}{8}$-$94\frac{7}{8}$	2	—	2	2	—	—	—	—	—	—	6
$94\frac{7}{8}$-$97\frac{7}{8}$	—	1	—	—	1	—	—	1	1	—	4
$97\frac{7}{8}$-$100\frac{7}{8}$	—	1	1	—	—	—	—	—	—	—	2
$100\frac{7}{8}$-$103\frac{7}{8}$	1	—	—	—	—	—	—	—	—	—	1
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	1	—	—	—	—	—	—	—	1
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—
$109\frac{7}{8}$-$112\frac{7}{8}$	—	1	—	—	—	—	—	—	—	—	1
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	—	—	—	1	1
Totals .	22	13	21	18	9	3	—	2	2	5	95

D 3.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	Sev.	Total.
$43\frac{7}{8}$-$46\frac{7}{8}$	—	—	—	—	—	1	1
$46\frac{7}{8}$-$49\frac{7}{8}$	—	—	—	—	—	—	—
$49\frac{7}{8}$-$52\frac{7}{8}$	—	1	—	—	—	—	1
$52\frac{7}{8}$-$55\frac{7}{8}$	—	1	1	1	—	—	3
$55\frac{7}{8}$-$58\frac{7}{8}$	2	2	4	1	1	—	10
$58\frac{7}{8}$-$61\frac{7}{8}$	—	2	2	—	1	—	5
$61\frac{7}{8}$-$64\frac{7}{8}$	3	1	2	1	—	1	8
$64\frac{7}{8}$-$67\frac{7}{8}$	7	3	8	1	2	—	21
$67\frac{7}{8}$-$70\frac{7}{8}$	4	2	8	3	3	1	21
$70\frac{7}{8}$-$73\frac{7}{8}$	4	1	15	1	3	1	25
$73\frac{7}{8}$-$76\frac{7}{8}$	6	6	6	—	4	1	23
$76\frac{7}{8}$-$79\frac{7}{8}$	8	5	7	6	3	1	30
$79\frac{7}{8}$-$82\frac{7}{8}$	8	2	4	1	1	1	17
$82\frac{7}{8}$-$85\frac{7}{8}$	3	2	3	1	—	—	9
$85\frac{7}{8}$-$88\frac{7}{8}$	5	1	6	2	—	—	14
$88\frac{7}{8}$-$91\frac{7}{8}$	4	1	2	1	2	—	10
$91\frac{7}{8}$-$94\frac{7}{8}$	1	2	1	2	1	—	7
$94\frac{7}{8}$-$97\frac{7}{8}$	2	1	—	1	2	—	6
$97\frac{7}{8}$-$100\frac{7}{8}$	3	1	—	1	1	—	6
$100\frac{7}{8}$-$103\frac{7}{8}$	1	—	1	—	—	—	2
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	—	—	—
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	—	—	—	—	—
$109\frac{7}{8}$-$112\frac{7}{8}$	1	1	1	—	—	—	3
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	—	—	—	—
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	—
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	1	—	—	—	1
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—
Totals .	62	35	72	23	24	7	223

D 4.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3	4.	5.	6.	7.	8.	Total.
$43\frac{7}{8}$-$46\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$46\frac{7}{8}$-$49\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$49\frac{7}{8}$-$52\frac{7}{8}$	1	—	—	—	—	—	—	—	1	2
$52\frac{7}{8}$-$55\frac{7}{8}$	—	1	1	2	—	1	—	—	—	5
$55\frac{7}{8}$-$58\frac{7}{8}$	3	2	2	1	1	—	—	—	—	9
$58\frac{7}{8}$-$61\frac{7}{8}$	4	4	3	—	1	—	—	—	—	12
$61\frac{7}{8}$-$64\frac{7}{8}$	3	2	4	2	4	—	2	—	—	17
$64\frac{7}{8}$-$67\frac{7}{8}$	6	9	8	3	1	1	3	—	—	31
$67\frac{7}{8}$-$70\frac{7}{8}$	8	2	7	3	3	2	—	—	—	25
$70\frac{7}{8}$-$73\frac{7}{8}$	8	9	8	5	2	1	—	—	—	33
$73\frac{7}{8}$-$76\frac{7}{8}$	5	6	4	3	1	1	—	—	—	20
$76\frac{7}{8}$-$79\frac{7}{8}$	6	5	11	1	2	1	—	1	—	27
$79\frac{7}{8}$-$82\frac{7}{8}$	2	4	7	3	1	1	1	—	—	19
$82\frac{7}{8}$-$85\frac{7}{8}$	5	4	5	4	—	—	—	—	—	18
$85\frac{7}{8}$-$88\frac{7}{8}$	—	1	5	3	1	1	1	—	—	12
$88\frac{7}{8}$-$91\frac{7}{8}$	3	3	4	3	3	—	—	—	—	16
$91\frac{7}{8}$-$94\frac{7}{8}$	—	2	3	2	1	1	—	—	—	9
$94\frac{7}{8}$-$97\frac{7}{8}$	2	2	4	2	—	—	—	—	—	10
$97\frac{7}{8}$-$100\frac{7}{8}$	—	1	—	1	—	2	—	—	—	4
$100\frac{7}{8}$-$103\frac{7}{8}$	1	—	1	—	—	—	—	—	—	2
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	1	—	1	—	—	2
$106\frac{7}{8}$-$109\frac{7}{8}$	—	1	1	1	—	—	—	—	—	3
$109\frac{7}{8}$-$112\frac{7}{8}$	—	—	1	—	—	1	—	—	—	2
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	1	—	—	—	—	—	—	1
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	1	—	—	—	1
Totals .	57	58	80	39	22	14	8	1	1	280

D 5.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	5.	Sev.	Total.
$43\frac{7}{8}$-$46\frac{7}{8}$	—	—	—	—	—	—	—	—
$46\frac{7}{8}$-$49\frac{7}{8}$	—	—	—	—	—	—	—	—
$49\frac{7}{8}$-$52\frac{7}{8}$	—	—	—	—	—	—	1	1
$52\frac{7}{8}$-$55\frac{7}{8}$	1	—	—	—	—	—	3	4
$55\frac{7}{8}$-$58\frac{7}{8}$	2	—	—	—	—	—	1	3
$58\frac{7}{8}$-$61\frac{7}{8}$	2	1	1	—	—	—	7	11
$61\frac{7}{8}$-$64\frac{7}{8}$	6	3	2	—	—	—	15	26
$64\frac{7}{8}$-$67\frac{7}{8}$	—	1	2	1	—	—	13	17
$67\frac{7}{8}$-$70\frac{7}{8}$	3	2	1	1	2	—	15	24
$70\frac{7}{8}$-$73\frac{7}{8}$	6	1	1	—	—	—	11	19
$73\frac{7}{8}$-$76\frac{7}{8}$	6	7	3	1	—	—	23	40
$76\frac{7}{8}$-$79\frac{7}{8}$	7	5	2	1	—	—	16	31
$79\frac{7}{8}$-$82\frac{7}{8}$	4	4	3	1	—	—	15	27
$82\frac{7}{8}$-$85\frac{7}{8}$	3	5	5	1	—	—	16	30
$85\frac{7}{8}$-$88\frac{7}{8}$	7	2	4	—	—	—	5	18
$88\frac{7}{8}$-$91\frac{7}{8}$	1	2	2	—	—	1	8	14
$91\frac{7}{8}$-$94\frac{7}{8}$	4	—	1	—	1	—	3	9
$94\frac{7}{8}$-$97\frac{7}{8}$	1	1	—	—	—	—	13	15
$97\frac{7}{8}$-$100\frac{7}{8}$	3	1	—	—	—	—	7	11
$100\frac{7}{8}$-$103\frac{7}{8}$	2	1	4	—	1	—	3	11
$103\frac{7}{8}$-$106\frac{7}{8}$	—	1	1	—	—	—	3	5
$106\frac{7}{8}$-$109\frac{7}{8}$	1	—	—	—	—	—	—	1
$109\frac{7}{8}$-$112\frac{7}{8}$	—	1	—	—	—	—	3	4
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	1	—	—	—	1
$115\frac{7}{8}$-$118\frac{7}{8}$	—	—	—	—	—	—	2	2
$118\frac{7}{8}$-$121\frac{7}{8}$	1	—	—	—	1	—	—	2
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—	—
Totals .	60	38	32	7	5	1	183	326

NUMBER OF CARIOUS TEETH AND WEIGHT.

Boys 13½.

D 2.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
46⅞- 49⅞	—	—	—	—	—	—	—	—	—	—
49⅞- 52⅞	—	—	—	—	—	—	—	—	—	—
52⅞- 55⅞	—	—	—	—	—	—	—	—	—	—
55⅞- 58⅞	—	—	—	3	—	—	—	—	1	4
58⅞- 61⅞	3	1	1	1	—	2	—	—	1	9
61⅞- 64⅞	1	4	3	2	1	—	—	—	—	11
64⅞- 67⅞	4	6	4	1	—	—	—	—	1	16
67⅞- 70⅞	8	2	3	—	1	4	—	1	4	23
70⅞- 73⅞	6	4	2	2	1	1	—	—	3	19
73⅞- 76⅞	10	6	8	3	4	—	—	—	2	33
76⅞- 79⅞	9	4	9	3	1	1	1	—	1	29
79⅞- 82⅞	9	5	7	2	—	3	1	1	4	32
82⅞- 85⅞	7	4	1	2	1	1	—	—	2	18
85⅞- 88⅞	4	2	1	4	1	—	—	—	1	13
88⅞- 91⅞	4	1	2	1	1	1	—	—	—	10
91⅞- 94⅞	3	—	3	2	—	—	—	—	—	8
94⅞- 97⅞	3	—	1	—	—	—	—	—	3	7
97⅞-100⅞	1	1	1	—	—	—	—	—	—	3
100⅞-103⅞	—	1	1	—	—	1	—	—	—	3
103⅞-106⅞	1	—	1	—	—	—	—	—	—	2
106⅞-109⅞	—	—	—	—	—	—	—	—	—	—
109⅞-112⅞	—	—	—	—	—	—	—	—	—	—
112⅞-115⅞	1	—	—	—	—	—	—	—	—	1
115⅞-118⅞	—	—	—	—	—	—	—	—	—	—
118⅞-121⅞	1	1	—	—	—	—	—	—	—	2
121⅞-124⅞	—	—	—	—	—	—	—	—	—	—
124⅞-127⅞	—	—	—	—	—	—	—	—	—	—
Totals .	75	42	48	26	11	14	2	2	23	243

D 3.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	Sev.	Totals.
46⅞- 49⅞	—	—	—	—	—	—	—
49⅞- 52⅞	—	—	—	—	—	—	—
52⅞- 55⅞	—	—	—	1	—	—	1
55⅞- 58⅞	—	—	2	—	1	—	3
58⅞- 61⅞	—	—	1	—	—	—	1
61⅞- 64⅞	4	1	2	—	1	1	9
64⅞- 67⅞	1	3	4	3	—	—	11
67⅞- 70⅞	3	2	12	2	2	—	21
70⅞- 73⅞	7	4	10	4	5	1	31
73⅞- 76⅞	5	3	12	3	1	2	26
76⅞- 79⅞	7	1	9	4	2	1	24
79⅞- 82⅞	5	3	6	—	1	2	17
82⅞- 85⅞	5	2	4	—	—	1	12
85⅞- 88⅞	4	5	5	4	2	1	21
88⅞- 91⅞	3	1	4	1	2	—	11
91⅞- 94⅞	2	1	2	2	—	3	10
94⅞- 97⅞	—	1	1	1	—	1	4
97⅞-100⅞	1	—	2	1	1	1	6
100⅞-103⅞	1	—	3	—	—	—	4
103⅞-106⅞	—	—	—	—	—	—	—
106⅞-109⅞	—	—	1	—	—	—	1
109⅞-112⅞	—	—	—	—	—	—	—
112⅞-115⅞	—	—	—	—	—	—	—
115⅞-118⅞	—	—	—	—	—	—	—
118⅞-121⅞	—	—	—	—	—	—	—
121⅞-124⅞	—	—	—	—	—	—	—
124⅞-127⅞	—	—	—	—	—	—	—
Totals .	48	27	80	26	18	14	213

D 4.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
46⅞- 49⅞	1	—	—	—	1	—	—	—	—	2
49⅞- 52⅞	—	—	—	—	—	—	—	—	—	—
52⅞- 55⅞	—	1	—	—	—	—	—	—	—	1
55⅞- 58⅞	—	—	1	4	—	—	—	—	—	5
58⅞- 61⅞	2	2	2	1	4	—	1	—	—	12
61⅞- 64⅞	5	5	5	6	—	1	—	—	—	22
64⅞- 67⅞	5	7	3	7	—	—	—	—	—	22
67⅞- 70⅞	5	9	7	4	—	2	1	—	—	28
70⅞- 73⅞	9	9	11	4	1	2	—	1	1	38
73⅞- 76⅞	4	7	10	8	1	3	—	—	—	33
76⅞- 79⅞	4	5	3	1	1	—	1	—	—	15
79⅞- 82⅞	4	5	5	1	1	2	1	—	—	19
82⅞- 85⅞	7	5	4	3	2	—	—	—	—	21
85⅞- 88⅞	1	3	5	2	—	—	1	—	—	12
88⅞- 91⅞	—	—	3	1	1	—	1	—	—	6
91⅞- 94⅞	2	—	2	—	—	—	—	—	—	4
94⅞- 97⅞	1	—	1	—	—	1	—	—	—	3
97⅞-100⅞	—	1	—	2	—	—	—	—	—	3
100⅞-103⅞	2	2	—	1	—	—	—	—	—	5
103⅞-106⅞	—	1	—	—	—	—	—	—	—	1
106⅞-109⅞	1	—	—	—	—	—	—	—	—	1
109⅞-112⅞	—	—	—	—	—	1	—	—	—	1
112⅞-115⅞	—	—	—	—	—	—	—	—	—	—
115⅞-118⅞	—	—	—	—	—	—	—	—	—	—
118⅞-121⅞	—	1	—	—	—	—	—	—	—	1
121⅞-124⅞	—	—	—	—	—	—	—	—	—	—
124⅞-127⅞	—	—	—	—	—	—	—	—	—	—
Totals .	53	63	62	45	12	12	6	1	1	255

D 5.

Weight in lb. / No. of Carious Teeth	0.	1.	2.	3.	Sev.	Totals.
46⅞- 49⅞	—	—	—	—	—	—
49⅞- 52⅞	—	—	—	—	—	—
52⅞- 55⅞	—	—	—	—	1	1
55⅞- 58⅞	—	—	—	—	3	3
58⅞- 61⅞	1	1	—	—	4	6
61⅞- 64⅞	—	—	—	—	8	8
64⅞- 67⅞	3	1	—	—	9	13
67⅞- 70⅞	1	1	1	—	18	21
70⅞- 73⅞	3	3	1	—	19	26
73⅞- 76⅞	6	3	2	—	26	37
76⅞- 79⅞	1	2	3	1	13	20
79⅞- 82⅞	4	3	4	—	11	22
82⅞- 85⅞	4	2	—	—	9	15
85⅞- 88⅞	4	1	2	—	11	18
88⅞- 91⅞	1	—	—	1	2	4
91⅞- 94⅞	3	—	1	—	—	4
94⅞- 97⅞	—	1	1	—	5	7
97⅞-100⅞	—	—	1	1	4	6
100⅞-103⅞	1	1	—	—	3	5
103⅞-106⅞	—	—	—	—	—	—
106⅞-109⅞	—	—	—	—	2	2
109⅞-112⅞	—	—	—	—	1	1
112⅞-115⅞	—	—	—	—	1	1
115⅞-118⅞	—	—	—	—	2	2
118⅞-121⅞	—	—	—	—	—	—
121⅞-124⅞	—	—	—	—	—	—
124⅞-127⅞	—	1	—	—	—	1
Totals .	32	20	16	3	152	223

NUMBER OF CARIOUS TEETH AND WEIGHT.

Girls 13½.

Weight in lb. (No. of Carious Teeth)	D 2. 0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	2	—	1	—	—	—	—	—	—	3
$55\frac{7}{8}$- $58\frac{7}{8}$	1	1	2	—	—	—	—	—	—	4
$58\frac{7}{8}$- $61\frac{7}{8}$	1	2	5	3	—	—	—	—	2	13
$61\frac{7}{8}$- $64\frac{7}{8}$	3	2	2	1	1	—	—	—	—	9
$64\frac{7}{8}$- $67\frac{7}{8}$	5	4	3	2	1	—	1	—	1	17
$67\frac{7}{8}$- $70\frac{7}{8}$	6	6	8	—	—	1	—	1	1	23
$70\frac{7}{8}$- $73\frac{7}{8}$	4	4	6	1	3	2	2	—	1	23
$73\frac{7}{8}$- $76\frac{7}{8}$	4	4	4	5	2	—	—	—	1	20
$76\frac{7}{8}$- $79\frac{7}{8}$	5	6	5	2	4	—	—	—	—	22
$79\frac{7}{8}$- $82\frac{7}{8}$	10	4	10	7	2	2	—	—	—	35
$82\frac{7}{8}$- $85\frac{7}{8}$	5	2	6	2	1	1	2	—	1	20
$85\frac{7}{8}$- $88\frac{7}{8}$	3	2	2	3	—	1	—	—	—	11
$88\frac{7}{8}$- $91\frac{7}{8}$	7	1	4	2	—	—	1	—	2	17
$91\frac{7}{8}$- $94\frac{7}{8}$	5	3	4	3	1	1	—	—	—	17
$94\frac{7}{8}$- $97\frac{7}{8}$	4	2	—	2	2	—	—	—	—	10
$97\frac{7}{8}$-$100\frac{7}{8}$	4	3	2	2	—	—	—	—	—	11
$100\frac{7}{8}$-$103\frac{7}{8}$	2	1	1	—	—	—	—	—	—	4
$103\frac{7}{8}$-$106\frac{7}{8}$	1	1	2	—	—	—	—	—	—	4
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	1	—	—	—	—	—	1	2
$109\frac{7}{8}$-$112\frac{7}{8}$	1	—	1	—	—	—	—	—	—	2
$112\frac{7}{8}$-$115\frac{7}{8}$	—	1	1	—	—	—	—	—	—	2
$115\frac{7}{8}$-$118\frac{7}{8}$	1	—	—	—	—	—	—	—	—	1
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$124\frac{7}{8}$-$127\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$127\frac{7}{8}$-$130\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
$130\frac{7}{8}$-$133\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—
Totals .	74	49	70	35	17	8	6	1	10	270

Weight in lb. (No. of Carious Teeth)	D 3. 0.	1.	2.	3.	4.	Sev.	Totals.
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	1	—	—	1	—	—	2
$55\frac{7}{8}$- $58\frac{7}{8}$	1	1	2	—	—	1	5
$58\frac{7}{8}$- $61\frac{7}{8}$	—	—	1	—	—	1	2
$61\frac{7}{8}$- $64\frac{7}{8}$	2	—	—	1	1	1	5
$64\frac{7}{8}$- $67\frac{7}{8}$	6	4	3	—	2	1	16
$67\frac{7}{8}$- $70\frac{7}{8}$	4	5	3	2	1	2	17
$70\frac{7}{8}$- $73\frac{7}{8}$	2	3	5	1	3	7	21
$73\frac{7}{8}$- $76\frac{7}{8}$	11	3	6	2	5	1	28
$76\frac{7}{8}$- $79\frac{7}{8}$	4	3	7	2	—	—	16
$79\frac{7}{8}$- $82\frac{7}{8}$	4	5	4	5	2	1	21
$82\frac{7}{8}$- $85\frac{7}{8}$	6	2	5	2	—	1	16
$85\frac{7}{8}$- $88\frac{7}{8}$	2	2	2	—	3	3	12
$88\frac{7}{8}$- $91\frac{7}{8}$	1	6	3	1	—	1	12
$91\frac{7}{8}$- $94\frac{7}{8}$	1	2	4	1	2	1	11
$94\frac{7}{8}$- $97\frac{7}{8}$	2	4	4	1	2	1	14
$97\frac{7}{8}$-$100\frac{7}{8}$	1	3	1	1	—	—	6
$100\frac{7}{8}$-$103\frac{7}{8}$	—	—	—	—	1	1	2
$103\frac{7}{8}$-$106\frac{7}{8}$	1	1	1	—	—	2	5
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	—	1	1	—	2
$109\frac{7}{8}$-$112\frac{7}{8}$	1	2	—	—	—	—	3
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	—	2	—	—	2
$115\frac{7}{8}$-$118\frac{7}{8}$	—	1	2	—	—	—	3
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	1	—	—	—	1
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—
$124\frac{7}{8}$-$127\frac{7}{8}$	1	—	—	—	—	—	1
$127\frac{7}{8}$-$130\frac{7}{8}$	—	—	—	—	—	—	—
$130\frac{7}{8}$-$133\frac{7}{8}$	—	—	—	—	—	—	—
Totals .	51	47	54	23	23	25	223

Weight in lb. (No. of Carious Teeth)	D 4. 0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Sev.	Totals.
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	1	—	—	—	—	—	—	—	—	1
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	1	—	1	1	—	—	—	—	—	—	3
$55\frac{7}{8}$- $58\frac{7}{8}$	1	—	—	1	—	—	—	—	—	—	—	—	2
$58\frac{7}{8}$- $61\frac{7}{8}$	1	2	2	4	2	1	—	1	—	—	—	—	13
$61\frac{7}{8}$- $64\frac{7}{8}$	3	6	3	1	1	—	—	—	—	—	—	—	14
$64\frac{7}{8}$- $67\frac{7}{8}$	1	1	8	1	—	—	—	—	—	—	1	—	12
$67\frac{7}{8}$- $70\frac{7}{8}$	—	4	4	1	2	1	—	—	—	—	—	—	12
$70\frac{7}{8}$- $73\frac{7}{8}$	10	5	2	4	—	—	1	—	—	—	—	—	22
$73\frac{7}{8}$- $76\frac{7}{8}$	8	9	6	5	2	1	1	—	—	—	—	—	32
$76\frac{7}{8}$- $79\frac{7}{8}$	3	2	8	4	—	1	—	—	—	—	—	—	18
$79\frac{7}{8}$- $82\frac{7}{8}$	3	4	4	4	3	1	2	—	—	—	—	—	21
$82\frac{7}{8}$- $85\frac{7}{8}$	4	3	5	4	—	—	—	—	—	—	—	1	17
$85\frac{7}{8}$- $88\frac{7}{8}$	5	5	5	3	2	—	2	—	—	—	—	—	22
$88\frac{7}{8}$- $91\frac{7}{8}$	1	1	3	1	2	1	—	—	—	—	—	—	9
$91\frac{7}{8}$- $94\frac{7}{8}$	1	4	2	3	—	—	—	—	—	—	—	—	10
$94\frac{7}{8}$- $97\frac{7}{8}$	—	—	2	—	1	—	—	—	—	—	—	—	3
$97\frac{7}{8}$-$100\frac{7}{8}$	1	1	1	3	—	—	—	—	—	—	—	—	6
$100\frac{7}{8}$-$103\frac{7}{8}$	—	—	3	—	1	—	—	—	—	—	—	—	4
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	1	1	1	2	—	—	—	—	—	—	5
$106\frac{7}{8}$-$109\frac{7}{8}$	—	—	1	1	—	—	—	—	—	—	—	—	2
$109\frac{7}{8}$-$112\frac{7}{8}$	—	—	1	1	—	—	—	—	—	—	—	—	2
$112\frac{7}{8}$-$115\frac{7}{8}$	—	—	1	—	—	—	—	—	—	—	—	—	1
$115\frac{7}{8}$-$118\frac{7}{8}$	—	1	—	—	—	—	—	—	—	—	—	—	1
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
$124\frac{7}{8}$-$127\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
$127\frac{7}{8}$-$130\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
$130\frac{7}{8}$-$133\frac{7}{8}$	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals .	42	48	63	43	18	9	6	1	—	—	1	1	232

Weight in lb. (No. of Carious Teeth)	D 5. 0.	1.	2.	3.	4.	Sev.	Totals.
$46\frac{7}{8}$- $49\frac{7}{8}$	—	—	—	—	—	1	1
$49\frac{7}{8}$- $52\frac{7}{8}$	—	—	—	—	—	—	—
$52\frac{7}{8}$- $55\frac{7}{8}$	—	—	—	—	—	—	—
$55\frac{7}{8}$- $58\frac{7}{8}$	—	1	—	—	—	1	2
$58\frac{7}{8}$- $61\frac{7}{8}$	3	—	1	—	—	2	6
$61\frac{7}{8}$- $64\frac{7}{8}$	2	—	—	—	—	6	8
$64\frac{7}{8}$- $67\frac{7}{8}$	1	2	1	—	—	7	11
$67\frac{7}{8}$- $70\frac{7}{8}$	2	1	1	1	—	7	12
$70\frac{7}{8}$- $73\frac{7}{8}$	2	1	3	1	—	9	16
$73\frac{7}{8}$- $76\frac{7}{8}$	2	1	3	—	—	10	16
$76\frac{7}{8}$- $79\frac{7}{8}$	1	—	3	—	—	18	22
$79\frac{7}{8}$- $82\frac{7}{8}$	1	2	—	1	—	8	12
$82\frac{7}{8}$- $85\frac{7}{8}$	2	3	1	1	—	12	19
$85\frac{7}{8}$- $88\frac{7}{8}$	1	1	2	1	—	6	11
$88\frac{7}{8}$- $91\frac{7}{8}$	1	—	2	—	—	12	15
$91\frac{7}{8}$- $94\frac{7}{8}$	1	2	1	—	—	9	13
$94\frac{7}{8}$- $97\frac{7}{8}$	1	1	—	1	—	5	8
$97\frac{7}{8}$-$100\frac{7}{8}$	2	—	—	—	—	4	6
$100\frac{7}{8}$-$103\frac{7}{8}$	—	1	—	—	—	2	3
$103\frac{7}{8}$-$106\frac{7}{8}$	—	—	—	—	—	6	6
$106\frac{7}{8}$-$109\frac{7}{8}$	1	—	—	—	—	1	2
$109\frac{7}{8}$-$112\frac{7}{8}$	1	—	1	—	—	2	4
$112\frac{7}{8}$-$115\frac{7}{8}$	—	1	—	—	1	2	4
$115\frac{7}{8}$-$118\frac{7}{8}$	—	1	—	—	—	—	1
$118\frac{7}{8}$-$121\frac{7}{8}$	—	—	—	—	—	1	1
$121\frac{7}{8}$-$124\frac{7}{8}$	—	—	—	—	—	—	—
$124\frac{7}{8}$-$127\frac{7}{8}$	—	—	—	—	—	—	—
$127\frac{7}{8}$-$130\frac{7}{8}$	—	—	1	—	—	—	1
$130\frac{7}{8}$-$133\frac{7}{8}$	—	—	—	—	—	1	1
Totals .	24	18	20	6	1	132	201

II. NUMBER OF CARIOUS TEETH AND NUTRITION.

Boys 13.

D 1.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Good .	1	—	2	—	1	—	—	1	—	5
Normal .	23	25	31	24	14	5	4	1	9	136
Subnormal	—	1	1	—	—	—	—	—	—	2
Bad . .	—	—	—	—	—	—	—	—	—	—
Totals .	24	26	34	24	15	5	4	2	9	143

D 2.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Good .	5	4	8	5	4	1	—	—	—	—	27
Normal .	8	20	41	15	12	6	4	—	2	4	112
Subnormal	2	1	—	—	3	1	2	—	—	1	10
Bad . .	—	1	—	—	—	—	—	—	—	—	1
Totals .	15	26	49	20	19	8	6	—	2	5	150

D 3.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4	5.	Sev.	Totals.
Good .	1	1	5	1	3	—	—	11
Normal .	48	29	65	31	10	—	6	189
Subnormal	11	7	25	4	5	1	4	57
Bad . .	—	—	—	—	—	—	—	—
Totals .	60	37	95	36	18	1	10	257

D 4.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals
Good .	2	3	3	—	1	—	—	—	—	9
Normal .	53	60	61	27	17	7	3	1	1	230
Subnormal	5	14	16	9	8	4	—	—	—	56
Bad . .	—	—	—	—	—	—	—	—	—	—
Totals .	60	77	80	36	26	11	3	1	1	295

D 5.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	11.	Sev.	Totals.
Good .	7	4	2	2	—	—	—	12	27
Normal .	44	27	19	4	—	—	1	132	227
Subnormal	13	5	4	1	—	1	—	81	105
Bad . .	—	—	—	—	—	—	—	1	1
Totals .	64	36	25	7	—	1	1	226	360

Girls 13.

D 1.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
Good .	2	4	5	3	1	2	—	—	17
Normal .	31	36	51	14	21	7	3	8	171
Subnormal	—	—	2	—	—	—	—	—	2
Bad . .	—	—	—	—	—	—	—	—	—
Totals .	33	40	58	17	22	9	3	8	190

D 2.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Good .	8	14	14	8	4	1	—	2	1	3	55
Normal .	34	12	27	18	11	4	1	2	1	6	116
Subnormal	3	1	2	2	—	—	—	—	—	—	8
Bad . .	—	—	—	—	—	—	—	—	—	—	—
Totals .	45	27	43	28	15	5	1	4	2	9	179

D 3.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Good .	9	2	8	—	2	—	21
Normal .	49	25	54	20	19	4	171
Subnormal	8	9	18	5	3	4	47
Bad . .	—	—	—	—	—	—	—
Totals .	66	36	80	25	24	8	239

D 4.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Good .	3	4	12	6	2	3	1	—	—	31
Normal .	44	50	60	24	21	11	6	1	—	217
Subnormal	18	12	15	12	5	1	1	—	1	65
Bad . .	—	—	—	—	—	—	—	—	—	—
Totals .	65	66	87	42	28	15	8	1	1	313

D 5.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Good .	10	4	8	1	3	—	22	48
Normal .	34	27	18	4	1	1	104	189
Subnormal	17	7	8	2	1	—	64	99
Bad . .	—	—	—	—	—	—	1	1
Totals .	61	38	34	7	5	1	191	337

NUMBER OF CARIOUS TEETH AND NUTRITION.

Boys 13½.

D 2.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Good	11	5	9	1	1	2	—	1	4	34
Normal	62	35	43	25	11	10	2	1	19	208
Subnormal	3	2	1	1	—	2	—	—	1	10
Bad	—	—	—	—	—	—	—	—	—	—
Totals	76	42	53	27	12	14	2	2	24	252

D 3.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Good	1	—	2	1	—	1	5
Normal	39	21	67	21	15	11	174
Subnormal	9	7	15	5	4	2	42
Bad	—	—	—	—	—	—	—
Totals	49	28	84	27	19	14	221

D 4.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Good	5	2	2	—	—	1	—	—	—	10
Normal	42	55	52	34	10	10	4	1	1	209
Subnormal	7	7	11	11	3	1	2	—	—	42
Bad	1	—	—	—	1	—	—	—	—	2
Totals	55	64	65	45	14	12	6	1	1	263

D 5.

Nutrition. No. of Carious Teeth.	0.	1.	2.	3.	Sev.	Totals.
Good	—	1	—	—	4	5
Normal	29	16	11	2	104	162
Subnormal	7	4	5	1	55	72
Bad	—	—	—	—	2	2
Totals	36	21	16	3	165	241

Girls 13½.

D 2.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Good	20	15	14	10	2	—	—	—	2	63
Normal	53	33	54	25	14	8	6	1	9	203
Subnormal	3	2	5	1	2	—	—	—	1	14
Bad	—	—	—	—	—	—	—	—	—	—
Totals	76	50	73	36	18	8	6	1	12	280

D 3.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Good	11	11	13	6	3	4	48
Normal	33	28	40	16	13	16	146
Subnormal	14	10	11	3	9	7	54
Bad	—	—	—	—	—	—	—
Totals	58	49	64	25	25	27	248

D 4.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Sev.	Totals.
Good	4	7	9	9	2	2	1	—	—	—	—	—	34
Normal	35	36	45	28	13	5	5	—	—	—	—	—	167
Subnormal	6	7	14	6	4	2	—	1	—	—	1	1	42
Bad	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	45	50	68	43	19	9	6	1	—	—	1	1	243

D 5.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Good	6	1	1	—	1	9	18
Normal	15	13	17	3	—	92	140
Subnormal	3	5	4	3	—	37	52
Bad	1	—	—	—	—	1	2
Totals	25	19	22	6	1	139	212

III.—NUMBER OF CARIOUS TEETH AND CLEANLINESS OF TEETH.

Boys 13.

No. of Carious Teeth.	D 1.									
	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Clean .	14	8	9	11	4	1	2	—	2	51
Unclean .	10	18	25	13	11	4	2	2	7	92
Totals .	24	26	34	24	15	5	4	2	9	143

No. of Carious Teeth.	D 2.										
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Clean .	13	23	46	16	17	5	5	2	—	4	131
Unclean .	2	3	3	4	2	3	1	—	—	1	19
Totals .	15	26	49	20	19	8	6	2	—	5	150

No. of Carious Teeth.	D 3.							
	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Clean .	38	22	63	20	11	1	3	158
Unclean .	22	15	32	16	7	—	7	99
Totals .	60	37	95	36	18	1	10	257

No. of Carious Teeth.	D 4.									
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean .	43	62	62	27	20	5	3	1	—	223
Unclean .	17	15	18	9	6	6	—	—	1	72
Totals .	60	77	80	36	26	11	3	1	1	295

No. of Carious Teeth.	D 5.								
	0.	1.	2.	3.	4.	5.	11.	Sev.	Totals.
Clean .	63	35	25	5	—	1	1	205	335
Unclean .	1	1	—	2	—	—	—	21	25
Totals .	64	36	25	7	—	1	1	226	360

Girls 13.

No. of Carious Teeth.	D 1.								
	0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
Clean .	18	28	31	7	13	6	1	2	106
Unclean .	15	12	27	10	9	3	2	6	84
Totals .	33	40	58	17	22	9	3	8	190

No. of Carious Teeth.	D 2.										
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Clean .	41	26	39	24	13	4	1	3	1	9	161
Unclean .	4	1	4	4	2	1	—	1	1	—	18
Totals .	45	27	43	28	15	5	1	4	2	9	179

No. of Carious Teeth.	D 3.							
	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Clean .	54	27	51	12	15	—	5	164
Unclean .	12	9	29	13	9	—	3	75
Totals .	66	36	80	25	24	—	8	239

No. of Carious Teeth.	D 4.									
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean .	51	56	74	30	22	9	4	—	—	246
Unclean .	14	10	13	12	6	6	4	1	1	67
Totals .	65	66	87	42	28	15	8	1	1	313

No. of Carious Teeth.	D 5.							
	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Clean .	59	37	33	7	4	1	179	320
Unclean .	2	1	1	—	1	—	12	17
Totals .	61	38	34	7	5	1	191	337

NUMBER OF CARIOUS TEETH AND CLEANLINESS OF TEETH.

Boys 13½.

No. of Carious Teeth.	D 2.									
	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Clean .	73	35	46	22	11	11	2	2	23	225
Unclean	3	7	7	5	1	3	—	—	1	27
Totals	76	42	53	27	12	14	2	2	24	252

D 3.						
0.	1.	2.	3.	4.	Sev.	Totals.
27	19	48	16	10	6	126
22	9	36	11	9	8	95
49	28	84	27	19	14	221

No. of Carious Teeth.	D 4.									
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean .	50	53	45	34	10	8	3	—	1	204
Unclean	5	11	20	11	4	4	3	1	—	59
Totals	55	64	65	45	14	12	6	1	1	263

D 5.					
0.	1.	2.	3.	Sev.	Totals.
35	19	16	3	155	228
1	2	—	—	10	13
36	21	16	3	165	241

Girls 13½.

No. of Carious Teeth.	D 2.									
	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Clean .	73	46	69	33	17	7	5	1	10	261
Unclean	3	4	4	3	1	1	1	—	2	19
Totals	76	50	73	36	18	8	6	1	12	280

D 3.						
0.	1.	2.	3.	4.	Sev.	Totals.
45	41	42	15	15	13	171
13	8	22	10	10	14	77
58	49	64	25	25	27	248

No. of Carious Teeth.	D 4.										
	0.	1.	2.	3.	4.	5.	6.	7.	10.	Sev.	Totals.
Clean .	39	44	55	34	14	7	2	1	—	1	197
Unclean	6	6	13	9	5	2	4	—	1	—	46
Totals	45	50	68	43	19	9	6	1	1	1	243

D 5.						
0.	1.	2.	3.	4.	Sev.	Totals.
25	19	21	6	1	125	197
—	—	1	—	—	14	15
25	19	22	6	1	139	212

IV. NUMBER OF CARIOUS TEETH AND DISCOLORATION.

B 13, D 1.

Colour.	Condition: Good.	Bad.	Totals.
Normal . . .	12	41	53
Discoloured . .	38	52	90
Totals . . .	50	93	143

B 13, D 3.

Colour.	Condition: Good.	Bad.	Totals.
Normal	109	123	232
Discoloured	28	35	63
Totals	137	158	295

B 13, D 4.

Colour.	Condition: Good.	Bad.	Totals.
Normal	22	62	84
Discoloured	75	98	173
Totals	97	160	257

G 13, D 1.

Colour.	Condition: Good.	Bad.	Totals.
Normal . . .	33	58	91
Discoloured . .	40	59	99
Totals . .	73	117	190

G 13 D 3.

Colour.	Condition: Good.	Bad.	Totals.
Normal	28	57	85
Discoloured	74	80	154
Totals	102	137	239

G 13, D 4.

Colour.	Condition: Good.	Bad.	Totals.
Normal	100	144	244
Discoloured	31	38	69
Totals	131	182	313

B 13½, D 3.

Colour.	Condition: Good.	Bad.	Totals.
Normal . . .	32	60	92
Discoloured .	45	84	129
Totals . .	77	144	221

B 13½, D 4.

Colour.	Condition: Good.	Bad.	Totals.
Normal	101	117	218
Discoloured	18	27	45
Totals	119	144	263

G 13½, D 3.

Colour.	Condition: Good.	Bad.	Totals.
Normal . . .	51	80	131
Discoloured .	56	61	117
Totals . .	107	141	248

G 13½, D 4.

Colour.	Condition: Good.	Bad.	Totals.
Normal	86	118	204
Discoloured	9	30	39
Totals	95	148	243

V. NUMBER OF CARIOUS TEETH AND STATE OF NOSE AND THROAT.

Boys 13.

D 1.

Nose and Throat. / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Normal	12	13	18	11	9	4	3	2	5	77
Not Normal	12	13	16	13	6	1	1	—	4	66
Totals	24	26	34	24	15	5	4	2	9	143

D 2.

Nose and Throat. / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	8.	Sev.	Totals.
Normal	7	8	23	6	9	4	4	1	2	64
Not Normal	8	18	26	14	10	4	2	1	3	86
Totals	15	26	49	20	19	8	6	2	5	150

D 3.

Nose and Throat. / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Normal	47	29	70	34	13	—	8	201
Not Normal	13	8	25	2	5	1	2	56
Totals	60	37	95	36	18	1	10	257

D 4.

Nose and Throat. / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal	45	48	61	22	19	10	1	1	1	208
Not Normal	15	29	19	14	7	1	2	—	—	87
Totals	60	77	80	36	26	11	3	1	1	295

D 5.

Nose and Throat. / No. of Carious Teeth.	0.	1.	2.	3.	5.	11.	Sev.	Totals.
Normal	54	29	21	6	1	1	179	291
Not Normal	10	7	4	1	—	—	47	69
Totals	64	36	25	7	1	1	226	360

Girls 13.

D 1.

	0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
Normal	19	22	31	9	8	6	1	5	101
Not Normal	14	18	27	8	14	3	2	3	89
Totals	33	40	58	17	22	9	3	8	190

D 2.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Normal	21	15	20	11	4	1	—	1	—	5	78
Not Normal	24	12	23	17	11	4	1	3	2	4	101
Totals	45	27	43	28	15	5	1	4	2	9	179

D 3.

	0.	1.	2.	3.	4.	Sev.	Totals.
Normal	53	30	71	17	16	4	191
Not Normal	13	6	9	8	8	4	48
Totals	66	36	80	25	24	8	239

D 4.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal	43	47	62	30	17	7	5	1	1	213
Not Normal	22	19	25	12	11	8	3	—	—	100
Totals	65	66	87	42	28	15	8	1	1	313

D 5.

	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Normal	46	31	27	4	4	—	149	261
Not Normal	15	7	7	3	1	1	42	76
Totals	61	38	34	7	5	1	191	337

NUMBER OF CARIOUS TEETH AND STATE OF NOSE AND THROAT.

Boys 13½.

Nose and Throat. No. of Carious Teeth.	D 2.									
	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Normal .	53	22	26	16	9	9	2	2	16	155
Not Normal	23	20	27	11	3	5	—	—	8	97
Totals .	76	42	53	27	12	14	2	2	24	252

Nose and Throat. No. of Carious Teeth.	D 3.						
	0.	1.	2.	3.	4.	Sev.	Totals.
Normal .	41	19	67	23	12	12	174
Not Normal	8	9	17	4	7	2	47
Totals .	49	28	84	27	19	14	221

Nose and Throat. No. of Carious Teeth.	D 4.									
	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal .	35	37	44	27	10	9	3	—	—	165
Not Normal	20	27	21	18	4	3	3	1	1	98
Totals .	55	64	65	45	14	12	6	1	1	263

Nose and Throat. No. of Carious Teeth.	D 5.					
	0.	1.	2.	3.	Sev.	Totals.
Normal .	28	16	13	3	118	178
Not Normal	8	5	3	—	47	63
Totals .	36	21	16	3	165	241

Girls 13½.

D 2.									
0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
47	32	44	22	10	4	5	—	8	172
29	18	29	14	8	4	1	1	4	108
76	50	73	36	18	8	6	1	12	280

D 3.						
0.	1.	2.	3.	4.	Sev.	Totals.
41	42	53	19	16	19	190
17	7	11	6	9	8	58
58	49	64	25	25	27	248

D 4.										
0.	1.	2.	3.	4.	5.	6.	7.	10.	Sev.	Totals.
29	30	44	28	14	8	4	1	1	—	159
16	20	24	15	5	1	2	—	—	1	84
45	50	68	43	19	9	6	1	1	1	243

D 5.						
0.	1.	2.	3.	4.	Sev.	Totals.
19	13	17	3	1	99	152
6	6	5	3	—	40	60
25	19	22	6	1	139	212

VI. NUMBER OF CARIOUS TEETH AND CLEANLINESS OF BODY AND HAIR.

Boys 13.

D 1.

Hair and Body. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals
Clean	17	12	23	19	5	3	3	2	6	90
Unclean	7	14	11	5	10	2	1	—	3	53
Totals	24	26	34	24	15	5	4	2	9	143

D 2.

Hair and Body. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Clean	14	19	43	18	13	4	5	—	2	3	121
Unclean	1	7	6	2	6	4	1	—	—	2	29
Totals	15	26	49	20	19	8	6	—	2	5	150

D 3.

Hair and Body. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Clean	54	36	92	33	16	1	10	242
Unclean	6	1	3	3	2	—	—	15
Totals	60	37	95	36	18	1	10	257

D 4.

Hair and Body. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean	56	66	74	33	25	10	3	1	1	269
Unclean	4	11	6	3	1	1	—	—	—	26
Totals	60	77	80	36	26	11	3	1	1	295

D 5.

Hair and Body. No of Carious Teeth.	0.	1.	2.	3.	5.	11.	Sev.	Totals.
Clean	48	28	23	6	1	1	191	298
Unclean	16	8	2	1	—	—	35	62
Totals	64	36	25	7	1	1	226	360

Girls 13.

D 1.

	0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
Clean	8	12	15	5	6	5	1	4	56
Unclean	25	28	43	12	16	4	2	4	134
Totals	33	40	58	17	22	9	3	8	190

D 2.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Clean	22	16	18	10	5	2	—	2	1	4	80
Unclean	23	11	25	18	10	3	1	2	1	5	99
Totals	45	27	43	28	15	5	1	4	2	9	179

D 3.

	0.	1.	2.	3.	4.	Sev.	Totals.
Clean	51	25	58	19	17	5	175
Unclean	15	11	22	6	7	3	64
Totals	66	36	80	25	24	8	239

D 4.

	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean	33	22	40	23	13	7	4	—	1	143
Unclean	32	44	47	19	15	8	4	1	—	170
Totals	65	66	87	42	28	15	8	1	1	313

D 5.

	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Clean	20	12	9	4	2	—	65	112
Unclean	41	26	25	3	3	1	126	225
Totals	61	38	34	7	5	1	191	337

NUMBER OF CARIOUS TEETH AND CLEANLINESS OF BODY AND HAIR.

Boys 13½.

D 2.

Body and Hair. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Clean .	61	33	43	18	9	9	2	2	16	193
Unclean .	15	9	10	9	3	5	—	—	8	59
Totals .	76	42	53	27	12	14	2	2	24	252

D 3.

Body and Hair. No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Clean .	46	24	76	25	16	12	199
Unclean .	3	4	8	2	3	2	22
Totals .	49	28	84	27	19	14	221

D 4.

Body and Hair. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Clean .	52	59	54	40	13	12	6	1	1	238
Unclean .	3	5	11	5	1	—	—	—	—	25
Totals .	55	64	65	45	14	12	6	1	1	263

D 5.

Body and Hair. No. of Carious Teeth.	0.	1.	2.	3.	Sev.	Totals.
Clean .	26	19	11	1	116	173
Unclean .	10	2	5	2	49	68
Totals .	36	21	16	3	165	241

Girls 13½.

D 2.

	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Clean	36	19	27	19	6	4	1	—	3	115
Unclean	40	31	46	17	12	4	5	1	9	165
Totals	76	50	73	36	18	8	6	1	12	280

D 3.

	0.	1.	2.	3.	4.	Sev.	Totals.
Clean	44	33	46	18	15	20	176
Unclean	14	16	18	7	10	7	72
Totals	58	49	64	25	25	27	248

D 4.

	0.	1.	2.	3.	4.	5.	6.	7.	10.	Sev.	Totals.
Clean	27	31	37	31	11	6	4	—	1	—	148
Unclean	18	19	31	12	8	3	2	1	—	1	95
Totals	45	50	68	43	19	9	6	1	1	1	243

D 5.

	0.	1.	2.	3.	4.	Sev.	Totals.
Clean	9	5	12	1	1	50	78
Unclean	16	14	10	5	—	89	134
Totals	25	19	22	6	1	139	212

VII. NUMBER OF CARIOUS TEETH AND ANÆMIA.

Boys 13.

D 1.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Normal .	22	22	30	21	14	4	3	2	7	125
Anæmic .	2	4	4	3	1	1	1	—	2	18
Totals .	24	26	34	24	15	5	4	2	9	143

D 2.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	8.	Sev.	Totals.
Normal .	13	21	42	16	12	7	3	2	3	119
Anæmic .	2	5	7	4	7	1	3	—	2	31
Totals .	15	26	49	20	19	8	6	2	5	150

D 3.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Normal .	57	35	91	34	18	1	9	245
Anæmic .	3	2	4	2	—	—	1	12
Totals .	60	37	95	36	18	1	10	257

D 4.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal .	54	69	69	29	23	8	3	1	1	257
Anæmic .	6	8	11	7	3	3	—	—	—	38
Totals .	60	77	80	36	26	11	3	1	1	295

D 5.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	5.	11.	Sev.	Totals.
Normal .	62	34	22	7	1	1	210	337
Anæmic .	2	2	3	—	—	—	16	23
Totals .	64	36	25	7	1	1	226	360

Girls 13.

D 1.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
Normal .	25	32	39	15	21	6	3	6	147
Anæmic .	8	8	19	2	1	3	—	2	43
Totals .	33	40	58	17	22	9	3	8	190

D 2.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
Normal .	31	16	33	17	13	2	—	2	—	7	121
Anæmic .	14	11	10	11	2	3	1	2	2	2	58
Totals .	45	27	43	28	15	5	1	4	2	9	179

D 3.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Normal .	60	33	70	20	21	5	209
Anæmic .	6	3	10	5	3	3	30
Totals .	66	36	80	25	24	8	239

D 4.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal .	57	54	73	35	23	13	7	1	1	264
Anæmic .	8	12	14	7	5	2	1	—	—	49
Totals .	65	66	87	42	28	15	8	1	1	313

D 5.

Blood. No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
Normal .	61	34	31	7	4	1	171	309
Anæmic .	—	4	3	—	1	—	20	28
Totals .	61	38	34	7	5	1	191	337

NUMBER OF CARIOUS TEETH AND ANÆMIA..

Boys 13½.

Blood. No. of Carious Teeth.	D 2. 0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Normal .	69	34	41	21	9	14	1	1	22	212
Anæmic .	7	8	12	6	3	—	1	1	2	40
Totals .	76	42	53	27	12	14	2	2	24	252

Blood. No. of Carious Teeth.	D 3. 0.	1.	2.	3.	4.	Sev.	Totals.
Normal .	47	27	83	27	18	12	214
Anæmic .	2	1	1	—	1	2	7
Totals .	49	28	84	27	19	14	221

Blood. No. of Carious Teeth.	D 4. 0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Normal .	51	57	58	38	11	12	6	1	1	235
Anæmic .	4	7	7	7	3	—	—	—	—	28
Totals .	55	64	65	45	14	12	6	1	1	263

Blood. No. of Carious Teeth.	D 5. 0.	1.	2.	3.	Sev.	Totals.
Normal .	35	18	14	3	155	225
Anæmic .	1	3	2	—	10	16
Totals .	36	21	16	3	165	241

Girls 13½.

D 2. 0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
60	42	55	31	12	8	5	—	10	223
16	8	18	5	6	—	1	1	2	57
76	50	73	36	18	8	6	1	12	280

D 3. 0.	1.	2.	3.	4.	Sev.	Totals.
55	46	59	18	23	24	225
3	3	5	7	2	3	23
58	49	64	25	25	27	248

D 4. 0.	1.	2.	3.	4.	5.	6.	7.	10.	Sev.	Totals.
41	44	60	35	17	6	6	1	—	1	211
4	6	8	8	2	3	—	—	1	—	32
45	50	68	43	19	9	6	1	1	1	243

D 5. 0.	1.	2.	3.	4.	Sev.	Totals.
23	18	21	4	1	124	191
2	1	1	2	—	15	21
25	19	22	6	1	139	212

VIII. NUMBER OF CARIOUS TEETH AND EMPLOYMENT OF FATHER.

Boys 13.

D 1.

Grade of Employment / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
A	7	3	5	5	4	2	1	1	—	28
B	5	4	3	2	1	1	—	—	2	18
C	3	2	4	3	2	—	2	—	—	16
D	4	5	3	2	2	—	—	—	3	19
E	—	3	5	4	—	—	—	—	—	12
F	5	5	12	5	5	1	—	1	3	37
Totals	24	22	32	21	14	4	3	2	8	130

D 2.

Grade of Employment / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	8.	Sev.	Totals.
A	2	6	5	2	1	1	1	—	1	19
B	1	4	8	5	7	—	—	—	1	26
C	4	5	9	3	6	1	1	1	—	30
D	1	2	3	—	1	1	—	1	1	10
E	2	2	3	—	—	—	1	—	—	8
F	3	2	13	4	1	3	2	—	1	29
Totals	13	21	41	14	16	6	5	2	4	122

D 3.

Grade of Employment / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	Sev.	Totals.
A	12	8	21	16	5	—	3	65
B	3	7	16	3	3	—	1	33
C	7	4	8	2	—	1	1	23
D	15	8	22	5	4	—	2	56
E	3	3	11	6	1	—	—	24
F	10	4	11	3	3	—	1	32
Totals	50	34	89	35	16	1	8	233

D 4.

Grade of Employment / No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
A	4	9	8	7	3	1	—	—	—	32
B	13	15	9	4	5	2	—	—	—	48
C	4	6	11	—	1	2	1	—	—	25
D	19	30	34	16	15	5	—	1	1	121
E	5	3	5	5	—	—	—	—	—	18
F	6	7	3	2	—	—	2	—	—	20
Totals	51	70	70	34	24	10	3	1	1	264

D 5.

Grade of Employment / No. of Carious Teeth.	0.	1.	2.	3.	5.	11.	Sev.	Totals.
A	10	8	7	2	—	—	34	61
B	6	2	5	1	—	—	21	35
C	10	9	4	2	—	—	41	66
D	4	4	1	1	—	1	26	37
E	—	1	—	1	—	—	6	8
F	26	8	4	—	1	—	74	113
Totals	56	32	21	7	1	1	202	320

Grades of Employment.—A = Clerks, Farmers, Shopkeepers, etc.
B = Skilled Trades and Iron Workers.
C = Transport Workers and those employed in Service.
D = Miners and Colliery Workers.
E = Factory Hands.
F = General and Farm Labourers.

NUMBER OF CARIOUS TEETH AND EMPLOYMENT OF FATHER.

Girls 13.

Grade of Employment. \ No. of Carious Teeth.	D 1. 0.	1.	2.	3.	4.	5.	6.	Sev.	Totals.
A	9	6	10	5	4	—	1	2	37
B	4	3	12	1	4	2	—	1	27
C	3	6	4	1	4	2	—	—	20
D	6	11	6	2	3	3	—	1	32
E	—	1	1	—	—	—	—	—	2
F	9	8	14	6	3	1	2	2	45
Totals	31	35	47	15	18	8	3	6	163

Grade of Employment. \ No. of Carious Teeth.	D 2. 0.	1.	2.	3.	4.	5.	6.	7.	8.	Sev.	Totals.
A	5	5	5	4	3	—	—	—	—	1	23
B	4	5	7	3	2	—	—	1	—	—	22
C	6	6	10	6	3	2	—	—	—	—	33
D	3	1	5	5	—	1	1	1	—	1	18
E	1	1	—	1	—	—	—	—	—	—	3
F	15	3	5	4	2	—	—	1	1	1	32
Totals	34	21	32	23	10	3	1	3	1	3	131

Grade of Employment. \ No. of Carious Teeth.	D 3. 0.	1.	2.	3.	4.	Sev.	Totals.
A	14	7	21	8	5	1	56
B	9	5	9	4	7	1	35
C	7	3	6	2	2	1	21
D	13	10	18	4	2	—	47
E	6	4	8	2	1	1	22
F	8	3	9	2	6	2	30
Totals	57	32	71	22	23	6	211

Grade of Employment. \ No. of Carious Teeth.	D 4. 0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
A	12	8	10	1	2	2	1	—	—	36
B	9	7	10	7	5	2	1	—	—	41
C	5	7	7	5	2	2	—	—	—	28
D	30	25	42	21	9	6	4	—	—	137
E	1	7	2	4	3	2	—	1	—	20
F	4	5	7	3	2	—	1	—	—	22
Totals	61	59	78	41	23	14	7	1	—	284

Grade of Employment. \ No. of Carious Teeth.	D 5. 0.	1.	2.	3.	4.	5.	Sev.	Totals.
A	10	11	7	3	1	1	22	55
B	4	6	6	2	—	—	31	49
C	11	6	8	1	1	—	33	60
D	4	2	4	1	—	—	15	26
E	2	—	—	—	—	—	4	6
F	23	10	3	—	2	—	63	101
Totals	54	35	28	7	4	1	168	297

NUMBER OF CARIOUS TEETH AND EMPLOYMENT OF FATHER.

Boys 13½.

D 2.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Grade of Employment. A	13	9	6	1	1	3	—	—	1	34
B	18	14	22	12	4	6	—	—	12	88
C	9	6	7	3	1	1	—	—	1	28
D	11	2	5	—	—	1	1	—	2	22
E	8	—	4	2	1	—	—	—	—	15
F	7	6	3	6	2	2	1	1	3	31
Totals	66	37	47	24	9	13	2	1	19	218

D 3.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Grade of Employment. A	6	3	10	3	1	2	25
B	15	5	12	5	8	3	48
C	1	1	7	1	—	—	10
D	16	15	33	14	5	5	88
E	3	2	3	—	—	—	8
F	3	2	6	1	2	2	16
Totals	44	28	71	24	16	12	195

D 4.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	8.	Totals.
Grade of Employment. A	7	6	4	6	—	2	1	—	—	26
B	22	24	29	19	3	4	2	—	1	104
C	3	2	6	3	3	—	—	—	—	17
D	15	13	9	6	6	2	—	1	—	52
E	1	5	1	3	1	—	—	—	—	11
F	3	2	3	3	1	1	—	—	—	13
Totals	51	52	52	40	14	9	3	1	1	223

D 5.

No. of Carious Teeth.	0.	1.	2.	3.	Sev.	Totals.
Grade of Employment. A	9	4	4	1	31	49
B	9	6	2	1	31	49
C	4	1	3	—	32	40
D	2	2	—	—	9	13
E	6	4	2	1	23	36
F	4	2	3	—	15	24
Totals	34	19	14	3	141	211

Girls 13½.

D 2.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	Sev.	Totals.
Grade of Employment. A	6	5	8	3	2	—	—	—	2	26
B	28	24	29	13	8	3	1	—	7	113
C	2	2	5	4	2	1	—	—	2	18
D	9	3	5	7	2	—	—	1	—	27
E	3	3	4	3	1	—	2	—	1	17
F	16	4	11	5	2	2	1	—	—	41
Totals	64	41	62	35	17	6	4	1	12	242

D 3.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Grade of Employment. A	4	2	7	1	4	5	23
B	13	16	7	9	6	3	54
C	2	2	4	1	—	2	11
D	25	19	30	10	10	14	108
E	1	3	4	1	—	—	9
F	7	1	2	—	2	1	13
Totals	52	43	54	22	22	25	218

D 4.

No. of Carious Teeth.	0.	1.	2.	3.	4.	5.	6.	7.	10.	Sev.	Totals.
Grade of Employment. A	3	4	8	5	2	—	—	—	—	—	22
B	18	30	31	14	8	6	5	1	1	—	114
C	2	—	6	1	—	1	—	—	—	1	11
D	13	7	14	13	7	2	—	—	—	—	56
E	2	3	1	4	—	—	—	—	—	—	10
F	2	4	2	2	—	—	—	—	—	—	10
Totals	40	48	62	39	17	9	5	1	1	1	223

D 5.

No. of Carious Teeth.	0.	1.	2.	3.	4.	Sev.	Totals.
Grade of Employment. A	4	3	6	—	—	23	36
B	6	6	5	4	1	31	53
C	1	3	1	—	—	20	25
D	3	—	1	—	—	8	12
E	2	5	6	1	—	24	38
F	4	2	1	—	—	9	16
Totals	20	19	20	5	1	115	180

IX. WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

Boys 13.

D 1.

Grade of Employment.	Weight in lb. 55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	Totals.
A	—	—	1	1	3	3	3	3	2	1	2	—	1	1	1	22
B	—	2	—	1	3	1	1	—	1	3	3	2	—	—	—	17
C	—	—	1	2	2	1	2	—	4	—	1	1	—	1	—	15
D	1	2	1	1	3	1	1	3	1	—	—	—	—	1	—	15
E	1	—	2	—	1	2	1	1	2	1	—	—	—	1	—	12
F	1	1	6	2	2	5	5	3	1	1	1	—	—	1	—	29
Totals .	3	5	11	7	14	13	13	10	11	6	7	3	1	5	1	110

D 2.

Grade of Employment.	Weight in lb. 52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	Totals.
A	—	—	—	—	1	1	2	—	4	1	—	2	—	—	11
B	—	—	—	—	—	2	2	3	3	3	2	—	1	—	16
C	—	1	—	3	1	3	—	4	2	—	2	1	1	1	19
D	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
E	1	1	—	1	2	1	—	—	1	—	—	—	—	—	7
F	—	—	2	3	—	5	1	3	2	1	1	—	—	—	18
Totals .	1	2	2	7	4	12	5	10	12	5	5	3	2	2	72

D 3.

Grade of Employment.	Weight in lb. 52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	Totals.
A	—	2	2	2	5	5	8	13	5	4	3	3	5	1	—	2	—	1	—	61
B	1	—	1	—	4	4	2	6	3	2	4	1	2	—	1	—	1	—	—	32
C	—	—	—	2	2	4	2	1	1	2	1	1	2	1	—	—	1	1	—	21
D	—	3	1	7	5	3	8	5	3	3	4	2	—	1	1	1	1	—	1	49
E	—	—	—	2	4	4	3	3	1	2	2	1	1	1	—	—	—	—	—	24
F	1	2	1	3	3	2	4	4	5	4	2	—	—	—	—	—	—	1	—	32
Totals .	2	7	5	16	23	22	27	32	18	17	16	8	10	4	2	3	3	3	1	219

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

Boys 13.

D 4.

Grade of Employment.	Weight in lb. 49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	Totals.
A	—	—	—	—	1	1	4	6	1	7	3	—	—	2	1	1	1	—	28
B	—	1	—	2	—	5	2	7	7	—	3	5	2	1	—	—	—	1	36
C	—	—	—	—	1	2	2	3	1	4	1	1	1	—	—	—	—	1	17
D	—	—	5	7	10	15	16	17	13	8	5	9	7	4	—	—	1	1	118
E	1	—	—	—	—	4	1	4	1	1	3	—	—	—	—	—	—	—	15
F	—	—	—	—	—	3	3	3	3	2	3	—	1	—	1	—	—	—	19
Totals .	1	1	5	9	12	30	28	40	26	22	18	15	11	7	2	1	2	3	233

D 5.

Grade of Employment.	Weight in lb. 43⅞–46⅞	46⅞–49⅞	49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	Totals.
A	—	—	—	—	—	—	3	5	5	4	4	4	12	6	3	5	3	1	1	1	—	1	—	—	—	58
B	—	—	—	1	—	—	2	3	5	3	3	5	5	2	3	1	1	—	—	1	—	—	—	—	—	35
C	1	—	—	—	—	4	1	5	5	11	6	10	4	4	2	2	4	—	3	—	—	—	—	—	1	63
D	—	—	—	—	1	1	1	3	3	8	4	5	2	4	—	—	—	—	—	—	—	—	—	—	—	32
E	—	—	—	—	—	1	1	1	—	1	2	—	1	—	—	—	1	—	—	—	—	—	—	—	—	8
F	—	—	—	1	1	3	12	12	14	16	13	5	12	5	5	5	2	1	—	1	—	—	1	—	—	109
Totals .	1	—	—	2	2	9	20	29	32	43	32	29	36	21	13	13	11	2	4	3	—	1	1	—	1	305

Girls 13.

D 1.

Grade of Employment.	Weight in lb. 49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	Totals.
A	2	—	—	1	2	3	1	2	3	1	3	3	2	3	—	—	1	1	—	—	—	—	—	28
B	—	—	1	—	2	—	3	2	1	—	2	3	2	2	1	2	—	—	—	—	—	—	—	21
C	—	—	1	2	1	2	—	1	2	1	1	1	2	—	1	2	—	1	—	—	—	—	1	19
D	—	—	1	1	1	4	3	3	—	1	2	4	—	1	1	1	—	1	—	—	—	—	—	24
E	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
F	—	1	—	2	3	5	5	1	4	5	4	1	2	—	1	—	1	—	—	1	—	—	—	36
Totals .	2	1	4	7	9	14	12	9	10	8	12	12	8	6	4	5	2	3	—	1	—	—	1	130

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

Girls 13.

D 2.

Grade of Employment.	Weight in lb. 55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	Totals.
A	—	—	—	—	2	2	1	—	2	2	—	—	2	—	—	—	—	—	—	11
B	—	—	1	—	4	1	—	—	2	2	—	1	—	2	—	1	—	—	—	14
C	1	—	2	—	1	—	2	2	1	3	1	1	2	—	—	—	—	—	1	17
D	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
F	—	2	2	—	2	3	3	—	2	1	1	1	1	1	1	—	—	—	—	20
Totals .	1	2	6	—	9	6	6	2	7	8	2	3	5	3	1	1	—	—	1	63

D 3.

Grade of Employment.	Weight in lb. 49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	Totals.
A	—	—	2	1	1	6	6	5	5	4	5	4	4	—	4	1	2	—	—	—	—	—	—	1	51
B	1	1	2	2	2	2	2	4	4	4	1	1	1	2	1	1	1	1	—	—	—	—	—	—	33
C	—	—	—	—	1	—	2	3	1	4	2	1	4	1	—	1	—	—	—	—	1	—	—	—	21
D	—	—	3	1	1	5	6	7	6	4	6	1	2	2	—	—	—	—	—	—	—	—	—	—	44
E	—	—	—	—	2	2	1	2	1	3	1	1	2	2	—	1	1	—	—	—	2	—	—	—	21
F	—	1	2	1	1	3	3	2	3	4	—	—	—	3	2	1	1	1	—	—	—	—	—	—	28
Totals .	1	2	9	5	8	18	20	23	20	23	15	8	13	10	7	5	5	2	—	—	3	—	—	1	198

D 4.

Grade of Employment.	Weight in lb. 49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	121⅞–124⅞	Totals.
A	—	—	—	2	2	3	1	5	3	4	2	2	3	2	1	1	—	1	—	1	—	—	—	—	—	33
B	—	2	—	2	1	2	6	4	1	1	5	2	1	2	1	1	—	—	—	—	—	—	—	—	—	31
C	—	—	1	1	1	1	3	5	1	2	1	2	—	—	2	—	—	—	—	2	—	—	—	—	—	22
D	1	3	5	6	10	17	13	13	9	11	6	5	6	6	3	4	2	—	2	—	2	1	—	—	—	125
E	—	—	2	—	1	—	—	—	3	3	1	3	1	1	1	2	—	—	—	—	—	—	—	—	1	19
F	—	—	—	—	—	5	—	3	1	4	1	3	1	2	—	1	—	1	—	—	—	—	—	—	—	22
Totals .	1	5	8	11	15	28	23	30	18	25	16	17	12	13	8	9	2	2	2	3	2	1	—	—	1	252

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

Girls 13.

D 5.

Grade of Employment.	Weight in lb.																							
	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	Totals.
A	—	—	3	4	3	3	3	6	3	3	8	5	1	—	4	1	—	1	—	3	—	2	—	53
B	2	1	—	5	3	1	3	5	1	5	9	3	1	1	4	3	1	1	—	—	—	—	—	49
C	1	1	3	3	4	5	3	10	6	4	1	3	1	4	1	2	2	1	—	—	1	—	—	56
D	—	—	—	3	1	5	1	2	—	7	3	—	1	1	—	—	2	—	—	—	—	—	—	26
E	—	—	—	—	—	—	1	—	1	—	—	—	2	1	—	1	—	—	—	—	—	—	—	6
F	1	1	4	11	6	6	6	10	15	6	5	5	6	2	4	3	4	1	—	1	—	—	2	99
Totals. .	4	3	10	26	17	20	17	33	26	25	26	16	12	9	13	10	9	4	—	4	1	2	2	289

Boys 13½.

D 2.

Grade of Employment.	Weight in lb.																						
	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	Totals.
A	—	—	1	—	4	1	5	6	2	6	—	2	—	2	2	—	1	—	—	1	—	—	33
B	—	5	7	7	8	8	11	10	13	2	3	3	3	3	1	1	—	—	—	—	—	—	85
C	1	1	—	—	2	2	3	2	7	1	3	1	1	1	—	2	—	—	—	—	—	—	27
D	—	2	1	1	3	3	2	3	2	1	2	—	—	—	—	—	—	—	—	—	—	—	20
E	1	—	—	2	—	3	1	5	—	—	1	1	—	—	—	—	—	—	—	—	—	1	15
F	1	—	1	3	3	—	5	1	8	1	1	2	2	1	—	—	—	—	—	—	—	—	29
Totals .	3	8	10	13	20	17	27	27	32	11	10	9	6	7	3	3	1	—	—	1	—	1	209

Boys 13½.

D 8.

Grade of Employment.	Weight in lb.																			
	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	Totals.
A	—	—	—	1	2	2	2	4	1	2	1	4	—	3	1	1	1	—	—	25
B	1	—	—	3	2	5	9	3	4	4	2	6	2	3	1	2	—	—	—	47
C	—	—	—	—	—	—	3	3	1	1	—	1	—	—	—	—	—	—	—	9
D	—	2	1	3	6	8	10	8	11	8	6	8	5	3	1	2	2	—	1	85
E	—	—	—	—	—	1	1	2	—	—	2	1	1	—	—	—	—	—	—	8
F	—	—	—	1	1	2	2	4	2	1	—	1	1	—	—	—	—	—	—	15
Totals .	1	2	1	8	11	18	27	24	19	16	11	21	9	9	3	5	3	—	1	189

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

Boys 13½.

D 4.

Grade of Employment.	Weight in lb. 46⅞–49⅞	49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	Totals
A	—	—	—	—	—	1	2	2	4	4	1	1	3	2	—	1	—	—	2	—	—	1	—	—	—	24
B	1	—	—	2	5	11	8	14	22	14	9	5	5	3	1	—	—	2	1	1	—	—	—	—	—	104
C	—	—	—	1	3	2	1	—	1	1	1	2	2	1	—	1	—	—	1	—	—	—	—	—	—	17
D	—	—	—	—	1	2	4	6	4	5	2	7	6	3	2	1	1	1	1	—	1	—	—	—	1	48
E	—	—	1	1	2	1	1	—	1	2	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	11
F	1	—	—	—	—	1	2	1	2	1	1	—	3	—	—	—	—	—	—	—	—	—	—	—	—	12
Totals .	2	—	1	4	11	18	18	23	34	27	14	15	20	9	4	3	1	3	5	1	1	1	—	—	1	216

D 5.

Grade of Employment.	Weight in lb. 52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	121⅞–124⅞	124⅞–127⅞	Totals.
A	—	—	1	2	4	4	3	3	7	6	2	4	1	1	1	2	2	—	2	1	—	—	—	—	—	46
B	1	—	—	2	1	5	4	10	4	4	2	4	1	—	4	—	2	—	—	—	—	1	—	—	—	45
C	—	1	2	1	2	1	8	3	4	4	1	5	1	1	—	1	—	—	—	—	1	—	—	—	1	37
D	—	—	—	1	2	1	3	2	—	2	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	13
E	—	—	2	2	2	6	2	10	1	1	4	1	1	—	—	1	—	—	—	—	—	—	—	—	—	33
F	—	1	1	—	1	2	3	3	3	2	2	1	—	2	1	1	—	—	—	—	—	—	—	—	—	23
Totals .	1	2	6	8	12	19	23	31	19	19	11	15	4	4	7	6	4	—	2	1	1	1	—	—	1	197

Girls 13½.

D 2.

Grade of Employment.	Weight in lb. 52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	Totals.
A	—	—	—	1	—	1	4	3	—	2	3	1	—	1	4	2	—	—	2	—	1	1	26
B	—	1	5	4	8	11	9	8	12	10	8	5	9	6	3	5	—	1	—	—	1	—	106
C	—	—	2	1	2	—	1	2	—	4	—	1	1	1	1	1	1	—	—	—	—	—	18
D	1	1	1	1	2	2	3	3	1	4	2	—	1	3	—	1	1	—	—	—	—	—	27
E	—	—	2	—	3	2	2	1	3	2	1	1	—	—	—	—	—	—	—	—	—	—	17
F	2	1	—	2	2	5	3	1	5	7	5	—	3	2	1	—	—	—	—	—	—	—	39
Totals .	3	3	10	9	17	21	22	18	21	29	19	8	14	13	9	9	2	1	2	—	2	1	233

WEIGHT OF CHILD AND EMPLOYMENT OF FATHER.

GIRLS 13½.

D 3.

	Weight in lb.																									
	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	121⅞–124⅞	124⅞–127⅞	Totals.
Grade of Employment. A	—	—	—	—	1	2	3	3	3	2	3	1	2	1	—	—	1	—	—	—	—	—	—	—	—	22
B	—	1	—	—	1	5	7	8	4	6	1	2	1	2	7	3	—	1	—	—	1	—	—	—	—	50
C	—	—	—	—	—	2	—	—	—	1	1	1	2	1	—	1	—	—	—	—	—	—	—	—	1	10
D	1	3	2	2	9	7	5	11	6	8	8	6	5	2	5	2	1	3	2	3	1	2	1	—	—	95
E	—	—	—	—	2	—	2	1	1	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	8
F	—	—	—	1	3	—	1	2	1	1	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	12
Totals .	1	4	2	3	16	16	18	25	15	18	13	10	10	10	12	6	2	5	2	3	2	2	1	—	1	197

D 4.

	Weight in lb.																							
	49⅞–52⅞	52⅞–55⅞	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	Totals.
Grade of Employment. A	—	—	—	—	1	2	—	—	3	4	4	2	2	1	—	—	2	1	—	—	—	—	—	22
B	1	2	1	9	9	6	7	12	18	6	10	4	9	6	1	2	2	1	—	—	—	—	1	107
C	—	—	—	1	—	—	2	—	—	1	1	2	—	—	—	—	—	—	1	—	1	1	—	10
D	—	—	1	1	2	1	3	6	5	4	4	5	5	1	7	1	1	2	4	—	—	—	—	53
E	—	—	—	—	2	—	—	—	—	1	1	1	2	—	1	—	1	—	—	1	—	—	—	10
F	—	—	—	1	—	—	—	2	3	—	—	1	1	1	1	—	—	—	—	—	—	—	—	10
Totals .	1	2	2	12	14	9	12	20	29	16	20	15	19	9	10	3	6	4	5	1	1	1	1	212

D 5.

	Weight in lb.																										
	55⅞–58⅞	58⅞–61⅞	61⅞–64⅞	64⅞–67⅞	67⅞–70⅞	70⅞–73⅞	73⅞–76⅞	76⅞–79⅞	79⅞–82⅞	82⅞–85⅞	85⅞–88⅞	88⅞–91⅞	91⅞–94⅞	94⅞–97⅞	97⅞–100⅞	100⅞–103⅞	103⅞–106⅞	106⅞–109⅞	109⅞–112⅞	112⅞–115⅞	115⅞–118⅞	118⅞–121⅞	121⅞–124⅞	124⅞–127⅞	127⅞–130⅞	130⅞–133⅞	Totals.
Grade of Employment. A	—	—	1	2	3	4	4	3	1	2	4	1	3	3	—	—	1	1	—	1	1	—	—	—	—	1	36
B	1	2	1	3	1	4	5	5	2	3	2	3	3	2	4	1	1	—	2	1	—	—	—	—	1	—	47
C	—	—	2	1	1	3	—	2	1	3	1	1	3	2	—	—	2	—	—	—	—	1	—	—	—	—	23
D	—	—	2	2	—	1	1	2	2	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	11
E	—	2	—	3	4	2	3	6	1	5	1	5	3	—	—	1	1	—	1	—	—	—	—	—	—	—	38
F	—	1	1	—	1	1	1	1	2	3	—	2	1	—	1	—	—	—	—	1	—	—	—	—	—	—	16
Totals .	1	5	7	11	10	15	14	19	9	16	8	12	13	7	5	2	5	1	4	3	1	1	—	—	1	1	171

X. NUTRITION AND WEIGHT.

Boys 13.

Weight in lb.	D 2. Good.	D 2. Normal.	D 2. Sub-normal.	D 2. Bad.	D 2. Totals.	D 3. Good.	D 3. Normal.	D 3. Sub-normal.	D 3. Totals.	D 4. Good.	D 4. Normal.	D 4. Sub-normal.	D 4. Totals.	D 5. Good.	D 5. Normal.	D 5. Sub-normal.	D 5. Bad.	D 5. Totals.
40⅞–43⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
43⅞–46⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46⅞–49⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
49⅞–52⅞	—	—	—	—	—	—	—	—	—	—	—	3	3	—	—	—	—	—
52⅞–55⅞	—	1	—	—	1	—	—	2	2	—	1	—	1	—	—	2	—	2
55⅞–58⅞	—	2	1	—	3	—	3	4	7	—	1	5	6	—	—	1	1	2
58⅞–61⅞	—	2	1	—	3	—	2	6	8	—	8	3	11	—	2	7	—	9
61⅞–64⅞	—	9	—	—	9	—	7	9	16	—	6	7	13	—	8	16	—	24
64⅞–67⅞	—	5	1	1	7	—	10	17	27	—	21	12	33	—	13	21	—	34
67⅞–70⅞	3	8	1	—	12	—	15	8	23	—	27	6	33	—	23	13	—	36
70⅞–73⅞	1	6	—	—	7	—	29	2	31	1	37	4	42	—	31	17	—	48
73⅞–76⅞	3	11	—	—	14	—	33	1	34	—	27	2	29	—	28	7	—	35
76⅞–79⅞	4	9	1	—	14	—	17	3	20	—	22	2	24	1	21	10	—	32
79⅞–82⅞	1	4	—	—	5	1	19	1	21	—	20	—	20	4	34	2	—	40
82⅞–85⅞	2	4	—	—	6	—	17	—	17	2	14	1	17	4	20	2	—	26
85⅞–88⅞	1	3	—	—	4	—	8	—	8	2	11	—	13	5	10	—	—	15
88⅞–91⅞	2	1	—	—	3	1	10	—	11	1	6	—	7	2	13	—	—	15
91⅞–94⅞	1	1	—	—	2	—	4	—	4	—	2	—	2	2	10	—	—	12
94⅞–97⅞	—	—	—	—	—	1	1	—	2	—	1	—	1	2	1	—	—	3
97⅞–100⅞	—	—	—	—	—	2	2	—	4	—	2	—	2	2	2	—	—	4
100⅞–103⅞	—	—	—	—	—	1	1	—	2	3	—	—	3	2	1	—	—	3
103⅞–106⅞	—	—	—	—	—	3	1	—	4	—	—	—	—	—	1	—	—	1
106⅞–109⅞	—	—	—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	1
109⅞–112⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
112⅞–115⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
115⅞–118⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
Totals .	18	66	5	1	90	10	179	53	242	9	206	45	260	26	219	99	1	345

NUTRITION AND WEIGHT.

Girls 13.

Weight in lb.	D 2. Good.	D 2. Normal.	D 2. Sub-normal.	D 2. Totals.	D 3. Good.	D 3. Normal.	D 3. Sub-normal.	D 3. Totals.	D 4. Good.	D 4. Normal.	D 4. Sub-normal.	D 4. Totals.	D 5. Good.	D 5. Normal.	D 5. Sub-normal.	D 5. Bad.	D 5. Totals.
43⅞–46⅞	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—
46⅞–49⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
49⅞–52⅞	—	1	—	1	—	—	1	1	—	—	2	2	—	—	1	—	1
52⅞–55⅞	—	—	—	—	—	—	3	3	—	1	4	5	—	—	4	—	4
55⅞–58⅞	—	1	—	1	—	4	6	10	—	4	5	9	—	1	2	—	3
58⅞–61⅞	—	3	—	3	—	1	4	5	—	5	7	12	—	1	10	—	11
61⅞–64⅞	—	8	—	8	—	2	6	8	—	11	6	17	—	6	19	1	26
64⅞–67⅞	—	1	1	2	—	12	9	21	—	25	8	31	—	8	9	—	17
67⅞–70⅞	—	13	1	14	—	15	6	21	—	15	10	25	—	11	13	—	24
70⅞–73⅞	—	6	1	7	—	22	3	25	—	25	8	33	1	12	6	—	19
73⅞–76⅞	1	7	1	9	—	20	3	23	—	16	4	20	2	24	14	—	40
76⅞–79⅞	—	6	—	6	1	28	1	30	—	25	2	27	2	22	7	—	31
79⅞–82⅞	3	7	—	10	—	16	1	17	2	17	—	19	1	20	6	—	27
82⅞–85⅞	4	5	—	9	—	9	—	9	1	16	1	18	3	25	2	—	30
85⅞–88⅞	—	2	—	2	3	11	—	14	1	11	—	12	4	13	1	—	18
88⅞–91⅞	3	4	—	7	3	7	—	10	5	11	—	16	3	11	—	—	14
91⅞–94⅞	4	2	—	6	1	6	—	7	3	6	—	9	2	6	1	—	9
94⅞–97⅞	4	—	—	4	5	1	—	6	3	7	—	10	6	9	—	—	15
97⅞–100⅞	2	—	—	2	1	5	—	6	3	1	—	4	3	8	—	—	11
100⅞–103⅞	1	—	—	1	2	—	—	2	2	—	—	2	9	2	—	—	11
103⅞–106⅞	1	—	—	1	—	—	—	—	2	—	—	2	3	2	—	—	5
106⅞–109⅞	—	—	—	—	—	—	—	—	3	—	—	3	1	—	—	—	1
109⅞–112⅞	1	—	—	1	3	—	—	3	2	—	—	2	1	3	—	—	4
112⅞–115⅞	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	1
115⅞–118⅞	1	—	—	1	—	—	—	—	—	—	—	—	2	—	—	—	2
118⅞–121⅞	—	—	—	—	1	—	—	1	—	—	—	—	2	—	—	—	2
121⅞–124⅞	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—
Totals .	25	66	4	95	20	159	44	223	29	194	57	280	46	184	95	1	326

NUTRITION AND WEIGHT.

Boys 13½.

Weight in lb.	D 2.				D 3.				D 4.					D 5.				
Nutrition	Good.	Normal.	Sub-normal.	Totals.	Good.	Normal.	Sub-normal.	Totals.	Good.	Normal.	Sub-normal.	Bad.	Totals.	Good.	Normal.	Sub-normal.	Bad.	Totals.
46⅞– 49⅞	—	—	—	—	—	—	—	—	—	—	1	1	2	—	—	—	—	—
49⅞– 52⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
52⅞– 55⅞	—	—	—	—	—	—	1	1	—	1	—	—	1	—	—	1	—	1
55⅞– 58⅞	—	4	—	4	—	1	2	3	—	2	3	—	5	—	—	2	1	3
58⅞– 61⅞	—	8	1	9	—	1	—	1	—	4	8	—	12	—	1	4	1	6
61⅞– 64⅞	—	11	—	11	—	2	7	9	—	11	10	1	22	—	1	7	—	8
64⅞– 67⅞	1	13	2	16	—	3	8	11	—	18	4	—	22	—	8	5	—	13
67⅞– 70⅞	1	19	3	23	—	10	11	21	—	24	4	—	28	—	11	10	—	21
70⅞– 73⅞	—	18	1	19	—	24	7	31	—	31	7	—	38	—	11	15	—	26
73⅞– 76⅞	4	28	1	33	—	24	2	26	—	32	1	—	33	—	23	14	—	37
76⅞– 79⅞	3	26	—	29	—	23	1	24	—	13	2	—	15	—	14	6	—	20
79⅞– 82⅞	4	27	1	32	—	15	2	17	1	17	1	—	19	—	21	1	—	22
82⅞– 85⅞	3	14	1	18	—	12	—	12	2	19	—	—	21	—	14	1	—	15
85⅞– 88⅞	2	11	—	13	—	21	—	21	—	12	—	—	12	—	18	—	—	18
88⅞– 91⅞	1	9	—	10	—	11	—	11	—	6	—	—	6	—	4	—	—	4
91⅞– 94⅞	4	4	—	8	1	8	1	10	1	3	—	—	4	—	4	—	—	4
94⅞– 97⅞	4	3	—	7	—	4	—	4	1	2	—	—	3	—	7	—	—	7
97⅞–100⅞	1	2	—	3	2	4	—	6	—	3	—	—	3	—	5	1	—	6
100⅞–103⅞	2	1	—	3	2	2	—	4	2	3	—	—	5	2	3	—	—	5
103⅞–106⅞	2	—	—	2	—	—	—	—	—	1	—	—	1	—	—	—	—	—
106⅞–109⅞	—	—	—	—	—	1	—	1	—	1	—	—	1	—	2	—	—	2
109⅞–112⅞	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	—	—	1
112⅞–115⅞	—	1	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	1
115⅞–118⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2
118⅞–121⅞	1	1	—	2	—	—	—	—	1	—	—	—	1	—	—	—	—	—
121⅞–124⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
124⅞–127⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
Totals .	33	200	10	243	5	166	42	213	9	203	41	2	255	4	150	67	2	223

NUTRITION AND WEIGHT.

Girls 13½.

Weight in lb.	D 2.				D 3.				D 4.				D 5.				
Nutrition	Good.	Normal.	Sub-normal.	Totals.	Good.	Normal.	Sub-normal.	Totals.	Good.	Normal.	Sub-normal.	Totals.	Good.	Normal.	Sub-normal.	Bad.	Totals.
46⅞– 49⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
49⅞– 52⅞	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
52⅞– 55⅞	—	1	2	3	—	—	2	2	—	1	2	3	—	—	—	—	—
55⅞– 58⅞	—	3	1	4	—	2	3	5	—	—	2	2	—	—	2	—	2
58⅞– 61⅞	—	12	1	13	—	—	2	2	—	4	9	13	—	3	2	1	6
61⅞– 64⅞	—	7	2	9	—	2	3	5	—	7	7	14	—	2	6	—	8
64⅞– 67⅞	1	13	3	17	—	5	11	16	—	9	3	12	—	6	5	—	11
67⅞– 70⅞	1	21	1	23	—	10	7	17	—	10	2	12	—	7	4	1	12
70⅞– 73⅞	2	20	1	23	1	16	4	21	—	20	2	22	—	6	10	—	16
73⅞– 76⅞	3	16	1	20	1	19	8	28	1	29	2	32	—	11	5	—	16
76⅞– 79⅞	2	19	1	22	—	12	4	16	1	15	2	18	—	13	9	—	22
79⅞– 82⅞	10	25	—	35	3	17	1	21	4	16	1	21	—	11	1	—	12
82⅞– 85⅞	5	14	1	20	3	13	—	16	3	12	2	17	—	17	2	—	19
85⅞– 88⅞	2	9	—	11	2	10	—	12	3	19	—	22	1	10	—	—	11
88⅞– 91⅞	3	14	—	17	1	10	1	12	3	6	—	9	1	14	—	—	15
91⅞– 94⅞	8	9	—	17	4	6	1	11	3	6	1	10	—	13	—	—	13
94⅞– 97⅞	6	4	—	10	8	6	—	14	1	2	—	3	1	6	1	—	8
97⅞–100⅞	7	4	—	11	3	3	—	6	3	3	—	6	3	3	—	—	6
100⅞–103⅞	3	1	—	4	2	—	—	2	2	2	—	4	1	2	—	—	3
103⅞–106⅞	1	3	—	4	5	—	—	5	4	1	—	5	2	4	—	—	6
106⅞–109⅞	2	—	—	2	1	1	—	2	2	—	—	2	1	1	—	—	2
109⅞–112⅞	2	—	—	2	2	1	—	3	1	1	—	2	2	2	—	—	4
112⅞–115⅞	2	—	—	2	2	—	—	2	—	1	—	1	3	1	—	—	4
115⅞–118⅞	1	—	—	1	3	—	—	3	1	—	—	1	1	—	—	—	1
118⅞–121⅞	—	—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	1
121⅞–124⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
124⅞–127⅞	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—
127⅞–130⅞	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
130⅞–133⅞	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
Totals .	61	195	14	270	43	133	47	223	32	164	36	232	18	133	48	2	201

XI.—NUTRITION AND ANÆMIA.

Boys 13.

Nutrition	D 2. Good.	Normal.	Sub-normal.	Bad.	Totals.	D 3. Good.	Normal.	Sub-normal.	Totals.	D 4. Good.	Normal.	Sub-normal.	Totals.	D 5. Good.	Normal.	Sub-normal.	Bad.	Totals.
Normal .	22	89	7	1	119	11	184	50	245	8	209	40	257	26	216	95	—	337
Anæmic .	5	23	3	—	31	—	5	7	12	1	21	16	38	1	11	10	1	23
Totals .	27	112	10	1	150	11	189	57	257	9	230	56	295	27	227	105	1	360

Girls 13.

Nutrition	D 2. Good.	Normal.	Sub-normal.	Totals.	D 3. Good.	Normal.	Sub-normal.	Totals.	D 4. Good.	Normal.	Sub-normal.	Totals.	D 5. Good.	Normal.	Sub-normal.	Bad.	Totals.
Normal .	40	76	5	121	20	152	37	209	29	184	51	264	44	178	86	1	309
Anæmic .	15	40	3	58	1	19	10	30	2	33	14	49	4	11	13	—	28
Totals .	55	116	8	179	21	171	47	239	31	217	65	313	48	189	99	1	337

Boys 13½.

Nutrition	D 2. Good.	Normal.	Sub-normal.	Totals.	D 3. Good.	Normal.	Sub-normal.	Totals.	D 4. Good.	Normal.	Sub-normal.	Bad.	Totals.	D 5. Good.	Normal.	Sub-normal.	Bad.	Totals.
Normal .	31	173	8	212	5	170	39	214	10	188	35	2	235	5	153	65	2	225
Anæmic .	3	35	2	40	—	4	3	7	—	21	7	—	28	—	9	7	—	16
Totals .	34	208	10	252	5	174	42	221	10	209	42	2	263	5	162	72	2	241

Girls 13½.

Nutrition	D 2. Good.	Normal.	Sub-normal.	Totals.	D 3. Good.	Normal.	Sub-normal.	Totals.	D 4. Good.	Normal.	Sub-normal.	Totals.	D 5. Good.	Normal.	Sub-normal.	Bad.	Totals.
Normal .	59	156	8	223	47	132	46	225	31	149	31	211	18	129	42	2	191
Anæmic .	4	47	6	57	1	14	8	23	3	18	11	32	—	11	10	—	21
Totals .	63	203	14	280	48	146	54	248	34	167	42	243	18	140	52	2	212

UNIVERSITY OF LONDON
FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS. VIII

The Influence of Defective Physique and Unfavourable Home Environment on the Intelligence of School Children,

Being a Statistical Examination of the London County Council Pioneer School Survey

BY

DAVID HERON, M.A.
[illegible]
IN THE UNIVERSITY OF LONDON

[illegible]

LONDON
PUBLISHED BY DULAU AND CO., LTD., 37 SOHO SQUARE, W.
1910

[illegible]

THE FRANCIS GALTON EUGENICS LABORATORY

University of London, University College, Gower Street, W.C.

The Laboratory is under the supervision of Professor Karl Pearson, F.
consultation with Mr. Francis Galton, F.R.S.

Francis Galton Fellow in National Eugenics: David Heron, M.A.

Francis Galton Scholar: Ethel M. Elderton.

Computer: Amy Barrington.

Advisory Committee:—The following have kindly consented to aid the S
the Laboratory in special forms of enquiry:—

W. Palin Elderton.
J. Macpherson, M.D.
F. Mott, M.D., F.R.S.
E. Nettleship.
Edgar Schuster, M.A.
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PRINTER TO THE UNIVERSITY

CONTENTS

THE TREASURY OF HUMAN INHERITANCE

ISSUED BY

THE FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

The Francis Galton Laboratory is issuing in parts at short intervals a collection of published and unpublished family pedigrees, illustrating the inheritance in man of mental and physical characters, of disease and of abnormality.

Students of heredity find great difficulty in obtaining easy access to material bearing on human inheritance. The published material is voluminous, scattered over a wide and often very inaccessible journalistic area. The already collected although unpublished material is probably as copious, but no central organ for its rapid publication in a standardized form exists at present. The Eugenics Laboratory alone possesses several hundred pedigrees of family characteristics and diseases which it is desirable to make readily accessible. Many medical men possess similar material, and there is a growing desire among genealogists to pay more attention to family characters and supplement the merely nominal pedigrees current in the past.

For a publication of this kind to be successful at the present time, it should be entirely free from controversial matter. The *Treasury of Human Inheritance* will therefore contain no reference to theoretical opinions. It will give in a standardized form the pedigree of each stock. This will be accompanied by a few pages of text describing the individual members of the stock, giving references to authorities, and, if the material has been published, to the *locus* of original publication. When necessary the characteristic will be illustrated by photography or radiography. In this way, it is hoped in the course of a few years to place a large mass of material in the hands of the student of human heredity. It will not cut him off from, but directly guide him to, original and fuller sources of information. Further, the *Treasury* will provide students of eugenics and of sociology, medical men, and others, with an organ where their investigations will find ready publication, and where as time goes on a higher and more complete standard of family history than has hitherto been usual can be maintained. It is proposed to issue the *Treasury of Human Inheritance* in quarto parts at about quarterly intervals. Each part will contain about 6 to 10 plates of pedigrees and of such other illustrations as may be needful.

The following parts have already been issued:—

Parts I and II (double part) contains pedigrees of Diabetes Insipidus, Split-Foot, Polydactylism, Brachydactylism, Tuberculosis, Deaf-Mutism, and Legal Ability. Price 14*s*.

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Single parts may be purchased from Messrs. Dulau & Co., Ltd., 37 Soho Square, London, W., either directly or through any bookseller.

THE INFLUENCE OF DEFECTIVE PHYSIQUE AND UNFAVOURABLE HOME ENVIRONMENT ON THE INTELLIGENCE OF SCHOOL CHILDREN

(1) Introductory.

The object of the present memoir is twofold: (*a*) to illustrate the difficulties that arise in attempting to make reliable and comparable observations on school children; and (*b*) to indicate the difficulties met with in the statistical treatment of such observations, if they are not made with due regard to the needs of the statistician.

The medical inspection of school children is now a recognized feature of our social life. We have high hopes of what it may effect in the future; but if it is not to disappoint us, if the harvest is to be worth the labour and its cost, we must definitely settle what we expect to learn from it and what we hope to do for the children by its aid. We shall be bitterly disappointed if we anticipate that definite results can be obtained by merely amassing data without much careful thought. We must determine first of all what are the right lines of inquiry and how best to standardize medical inspection and especially the teachers' powers of observation. Above all, we have to remember that the real complexities of the problems before us are very far from being realized at the present time.

Great Britain is a country of many "local races". Such characters of children as stature and weight vary from local race to local race precisely as eye and hair colours do. In the schools of a large town it is quite usual to find significant pigmentation differences in the different districts. No instructed student of anthropometry attributes these differences to the effects of environment; they are due, he knows well, to different racial proportions in the different districts; the Irish, the Jewish, the Scandinavian, and the Anglo-Saxon elements are there in varying proportions, and in many big towns even a study of the children's names is sufficient to show the varying proportions of these or other races.

Now stature and weight are as markedly differentiated among these racial types as are hair colour, eye colour, or shape of head. What is more, their eyesight, their hearing, and their standard of clothing are often widely differentiated as well. No study of the physique of the school child will be of service unless it is associated with some determination of the racial elements in the schools under

consideration. Inquiries as to origin of parents and observations on eye and hair colour must accompany the determination of other physical characters. If the children attending a school in a poor neighbourhood are found to be much under the average height and weight, this may be a result of the environment, but it may equally well be found that the pigmentation of the children is differentiated also, and that on further inquiry there is a large number of immigrants, Irish or Italians perhaps, in the district. Indeed the environment itself may be racially selective, driving out the physically superior and attracting a physically inferior population.

The moment these points are fully realized it will be seen how difficult it is to obtain any results of a really helpful nature by comparing height and weight curves of children from different districts, or from schools in the same large town but in different quarters, or of children of different social grades. It is idle, for example, to compare Lancashire and Devonshire children, or either, with a most misleading "British Association Standard",* and to suppose that anything may be learnt from the result as to the influence of factory or rural environment on the physique of the children. To do so may be to attribute to environment differences which are as purely racial as proportions of hair and eye colours.

In drawing up schemes for the medical inspection of school children, these points must eventually be fully recognized. Mere heights, weights, and chest measurements are of little service, and yet these are being obtained at the present time in endless numbers; the percentage growth of these characters per annum in the individual child would probably be more free from racial influence, but even this point has not up to the present received due attention, and records of parental origin and of pigmentation are the most essential needs of the present schemes.

Even where we are certain of uniformity of race, we cannot assert that differences in physique are due to differences in environment. Let us suppose that the mentally and physically inferior child has been shown in some fairly homogeneous material to be associated with the more unsatisfactory surroundings; we have still to ascertain whether this inferior environment may not be the centre to which the physically and mentally inferior parents naturally gravitate. What we really want to know is whether, for a constant type of parent, the environment is a substantial factor in determining the mentality and physique of the child.

* The British Association standard stature and weight for each year of age were based on records obtained from all parts of the country, and possibly gave a fair idea of the average stature and weight of the child population of this country. But when the average heights and weights of the children of any district are found to fall below this standard, it is quite unjustifiable to assume, as has been done so often, explicitly or tacitly, that this is due to some unfavourable conditions in the district. Until we know the average heights and weights of each racial element of the general population and of the particular district selected for comparison, making due allowance for age, we have no means of saying whether the differences are due to environmental conditions or are purely racial.

Now it will be evident that this cannot be ascertained until we have some information about the parents. The school records of children will never meet national demands until they are extended to cover some inquiry as to the parents and the home conditions. This is not a possibility of the present medical inspection scheme, but none the less it cannot be ignored. It is not possible to assert that defective mentality or physique is due to environmental conditions until some study has been made of the home and the parents. There may be a relationship between physique and environment which is merely an indirect effect of heredity resulting from the selective action of environment upon the parents. It would seem that the point we are dealing with here is a vital one; its solution is to be found in supplementary surveys—independent of the school medical survey—carried out by energetic social workers.

Child-life is the most valuable asset of the nation; on what is its fitness principally based? The future of the nation truly depends on an exact answer to that question. The problem is exceedingly complex and subtle; it cannot be fully answered without surveys of homes and parents. The work of Charles Booth has shown that much can be done in this direction by even a single man with the needful resources; the work of the Edinburgh Charity Organization Society shows that still more valuable results can be obtained by the co-operative action of school authorities, medical officers, and social workers.

The legislation of the future is certain to be of a more and more social character, but the value of that legislation will depend on the attention paid to the more weighty factors influencing the fitness of the child. What is the relative importance of heredity, of moral, of economic, and of hygienic environment on the mentality and physical fitness of the child? We have assumed the answers in the past; they must be found in the future by the same type of laborious research as we now give to any physical or biological problem.

Well-planned school medical inspection combined with standardized observation on the part of the teachers will provide the easier portion of the necessary data, but the harder portion must fall to the part of organized social inquiry. The time has come when it is needful for further social progress that we should follow up not only the school child but also the pauper, the mentally defective and the criminal, into their homes, and study from the standpoint of science—that is, without prejudgment and with bridled emotions—the relative importance of the conditions which produce the pauper, the imbecile, and the criminal.

In all these cases the problem before us is: Given a constant type of parent, what effect has environment on the child? Stating the problem analytically we have the following factors: p, the measure of any character in the parent; c, the measure of that character in the child; and e, the environmental factor. We have then r_{cp}, the correlation between child and parent for the character under

consideration, the intensity of heredity; r_{ep}, the correlation between the environment and the character in the parent; and r_{ec}, the correlation between the environment and the character in the child.

Now if we wish to find the relationship between the character under consideration in the child and the environment, independently of the measure of the character in the parent, i. e. independently of the influence of heredity, we must use the partial correlation coefficient,

$$_pR_{ec} = \frac{r_{ec} - r_{cp}r_{ep}}{\sqrt{1-r_{cp}^2}\ \sqrt{1-r_{ep}^2}}.$$

This value would be zero if the relationship $r_{ce} = r_{cp}r_{ep}$ held.

Now we are fairly certain that the value r_{cp}, the correlation between parent and child for any character, does not differ widely from ·5. What we do not know is the extent to which the environment selects the parents by their physique or mentality. But it is exceedingly probable that the mentally and physically inferior parents gravitate to the inferior environment. If this relationship were only of the order ·2, it would be needful for r_{ec}, the observed correlation between the environment and the character in the child, to be greater than ·10 for any definite effect of environment, independent of heredity, to show itself on the child. For values of r_{ep} from ·3 to ·4 we must have r_{ec} greater than ·15 or ·20; and for closer selective action of environment on parental character, we must have still higher values of r_{ec}. Now all the values of r_{ec} so far obtained are small quantities of this kind between·00 and·20; they are such that we may reasonably suppose R_{ec} small or zero if there be any sensible value for r_{ep}. In other words, they are compatible with little or no influence of environment on child for parent of constant type. High values of r_{ec}, i. e. values about ·5, would mean that r_{ep}, to produce a zero R_{ec}, must needs be above unity, which is impossible.

Unless r_{ec} comes out greater than ·5, we cannot argue, without investigating the relationship between parent and environment, that R_{ec} is significant; it *probably* is if r_{ec} is greater than ·3 or ·4. But for such values as ·00 to ·20 actually found in this paper, the only safe conclusion seems to be that environment has very little, if any, influence, and what influence it has may be an indirect effect of heredity acting by environment selecting the parents. As an illustration of this point we may refer to Miss Elderton's result that children of fathers with an "unhealthy" trade have somewhat less stature and weight. This relationship, however, need not depend on the unhealthiness of the father's trade, but on the possibility that the man is a shoemaker, say, and not a blacksmith, because he is physically inferior and will accordingly have physically inferior offspring.

The points discussed above have been referred to because it is needful at present to insist on the fact that school data without home data will not solve the most urgent national problems, and further to explain what interpretation must be placed on our results.

Correlations in material such as the present must be of a marked kind, say at least of ·3 or ·4, and established by several independent investigations, to allow of our asserting that unfavourable home environment or defective physique is influencing the intelligence of the children.

(2) Material.

We have seen in the above introduction that for the full answer to the questions which concern the eugenist and the philanthropist we can only look to the records of medical inspection supplemented by careful sociological surveys. Such alone can tell us the relative weights of heredity and of environment, and, above all, show us the exact environmental facts which are influential. Much of this search must be of the nature of experiment, of groping for influential environmental factors, and of seeking for practical methods of effective record and observation. It will be a great waste of time, labour, and money, if all the independent educational authorities of this country start individual inquiries without regard to the experience to be gained from the analysis of earlier attempts on the part of the pioneers in this field. Even inquiries which are largely negative in character are of first-class importance as marking out lines of no thoroughfare. It would be the greatest blindness to suppose that such an inquiry as that initiated by the London School Board in 1904 was of little profit because on so many points it has led to negative results. It is, on the contrary, a pioneer investigation, which, if its lessons are properly studied and applied, ought to save the educational authorities of this country many thousands of pounds and much vain labour. The danger is that they will be content to learn from their own experience without appreciating what this inquiry has shown to be possible or profitable.

The Francis Galton Laboratory has examined five distinct school inspection inquiries, dealing with children in London, in Glasgow, two with children in Edinburgh, and one with children in Aberdeen. The staff of that Laboratory feel certain that in all these pioneer investigations each system of observation and record had much to learn from the results of the other systems and from the statistician as to what type of observation can be of service from the mere standpoint of numerical reduction and the safe deduction of conclusions.* Further, no future investigation can afford to neglect the experience of these earlier inquiries. For instance, one of these investigations statistically leads to the conclusion that defective hearing is not sensibly associated with bad teeth. This has either to be accepted as a definite conclusion, or the observations on teeth and ears must be

* Such points as placing 90 per cent. of the children in one class and the remaining 10 per cent. in five or more classes, the choice of only two classes when for statistical purposes three at least are desirable, the use of terms at different centres with wholly different values, and the tendency to club together as over or under a certain value the "tails" of frequency distributions may be noticed as instances in point.

made on a different plan. The pioneer inquiry is one which must not be disregarded if additional observations are to give any new knowledge; and illustrations of this point could be multiplied twenty-fold. Either the negative results obtained from these pioneer inquiries are correct and therefore do not need repetition, or, if doubt be felt with regard to them, the observations must meet the criticisms which can be raised against the first admittedly experimental investigations. It is from this standpoint that we appreciate, and we hope other investigators will appreciate, the generosity with which the Education Committee of the London County Council has placed its data at the disposal of the Laboratory for reduction and criticism. More at present is to be learnt by careful statistical examination of these pioneer inquiries than by any repetition of them until we have determined what exactly is feasible, what lines of research are profitable, and what preliminary standardization and special training are necessary.

The periodical stocktaking of the child-life of the community may turn out to be the most remarkable factor in our future understanding of what tends to strengthen national welfare; or it may simply lead to the accumulation of records from which no real knowledge can be extracted, and which will soon be taken on that very account, in a non-intelligent and perfunctory manner. The success of the medical inspection of schools depends not only on the enthusiasm of the first medical officers, it depends on the co-ordination of many factors, the teacher, the social worker, and the trained statistician. We must, above all, advance slowly, weighing the experience of each new record before starting more elaborate systems.

The history of the material used in this paper is of some interest. In his Report for 1903,* Dr. Kerr says: "We have no trustworthy measurements of the development of London children. The necessity for a very large number of measurements, requiring a considerable time to effect, at present stands in the way. The smallest number of measurements to give trustworthy results for purposes of comparison in different groups or with other standards would amount to many thousands. It is desirable that such should be obtained for boys and girls at each quarter year of age from 5 to 15. All measurements not absolutely necessary being avoided, there would be required:

Sex, standard, school; age in years and months; weight in clothes; height (without shoes); chest girth (full and empty)."

A few months later † this proposal took definite shape, and it was suggested that an investigation should be initiated to show the relations between (*a*) the educational status, (*b*) the physical condition, and (*c*) the social position of the child. It was hoped that this investigation might cover at least 20,000 children.

For those characters which could not be expressed on a quantitative scale, a system of marks, 1, 2, 3, 4, 5, was suggested: one mark indicating a condition

* First Annual Report of the Medical Officer to the School Board of London, p. 2.

† Report of the Medical Officer of the late School Board of London, 1904, p. 4.

which ought not to be allowed to continue and which required immediate relief; two marks indicating a sub-normal, markedly inferior, or poor condition; three marks, a fairly normal state, neither markedly below nor decidedly above the average; four marks, a condition distinctly above the average; and five marks, a condition of high excellence. Doubtful cases were to be marked on the side towards the average. How far such a system of marks has been successful will be considered later.

As an indication of the educational status of the child, it was suggested that the teacher should state the standard and should give an estimate of the all-round mental capacity of each child dealt with. It was proposed that one mark should be given for a very dull and backward child; two marks for one distinctly below the average; three marks for the average child; four marks for a distinctly sharp child; while five marks would be given for a particularly clever and bright child. Doctor, teacher, and school attendance officer were all to co-operate in the work; the doctor was to give the age, height, weight, condition of clothing, and the results of a superficial examination of the hair, cervical glands, eyelids, teeth, &c.; the part to be played by the teacher has already been indicated, and the school attendance officer was to obtain information from which an estimate could be made of the home conditions of the child, such as the number of rooms occupied, the number of individuals living in those rooms, &c.

After considerable discussion, it was decided by the Committee that this inquiry, which would cost, if based upon records of 50,000 children, about £700, or less than 3½*d.* a head, should be indefinitely postponed.

It is very earnestly to be hoped that this investigation may yet be carried out. It is only by a full scheme of the kind suggested that a true picture could be formed of the very varied child-life of London. But the many and manifold advantages that would flow from such a survey of the school children of London need not be further emphasized.

Although this comprehensive scheme could not be carried out, a couple of measuring standards were obtained and the work was started on a small scale and still continues. The present investigation deals with the material so obtained. We have further to thank Dr. Kerr for his ready help and advice in many matters relating to the survey. Various portions of the material have already been analysed and the results published in the Annual Reports of the Medical Officer of the Education Committee of the London County Council; but there has been no systematic attempt to reduce the statistics by modern methods.

The observations dealt with in this paper refer to 14 different schools, but in 1 school the observations on the boys only could be used, and in 2 schools those on the girls only could be used, so that we are really considering 12 boys' schools and 13 girls' schools.

The different schools will throughout the paper be distinguished by numbers,

such as *B.* 6 and *G.* 8, *B.* denoting a boys' school and *G.* a girls' school, while *B.* 6 and *G.* 6 refer to the boys and girls of the same school, No. 6.

By the kindness of the head masters and head mistresses of the schools, and of the medical men who carried out the investigation, the following notes on the individual schools have been supplied, in order that some idea of the character of the schools might be obtained.

B. 1 and *G.* 1. The children attending this school belong for the most part to families of the casual labour class, and, especially during the winter months, suffer from inadequate feeding and clothing. The housing question presses very severely, rents being high, and the accommodation, mostly provided in high block dwellings, very limited.

B. 2 and *G.* 2. This school is situated in a district of a very mixed character. It was built recently, and is attended by the children of the worse section of the population, the better classes going to the older schools in the district. At the time of the investigation there was much unemployment in the district and much drinking, but a characteristic feature of the locality is the rapid changes among the people. This is well shown by the following table, which gives the number of children who were admitted to and who left the school, and the average number on the roll for three years.

TABLE I.

Year ending.	Number of children admitted.	Number of children left.	Average Number on the Roll.
Jan. 31, 1907	158	155	285
„ „ 1908	180	188	280
„ „ 1909	148	140	274

The table shows that more than 50 per cent. of the children left within the year.

B. 3 and *G.* 3. This school is situated in a fairly well-to-do neighbourhood; the pupils are the children of city clerks, artizans, and fairly prosperous tradespeople. The neighbourhood is rather low and damp, and there is a fair amount of rheumatism, chorea, &c.

B. 4 and *G.* 4. Many of the children attending this school come from very poor homes, and some are of the gutter-children type, but many also are the children of small tradespeople and others in fairly good positions. There are very few, however, of the lowest class. This is shown by the fact that during the winter only 30 cases required feeding out of 330, and never more than 20 at a time. Some of these were fed only for a short time, "while father was out of work". The houses are mostly small, but, though there is still some overcrowding, the worst spots have been cleared away.

B. 5 and *G.* 5. This school is situated in the Bethnal Green district. About 25 per cent. of the children are Jews.

B. 6 and *G.* 6. This school is situated in a low-lying and damp neighbourhood, and the children suffer from chorea, enlargement of glands, tonsils, and adenoids, and from rheumatism and deafness. The children are of a very well-to-do class; there are only three or four poor children in each department.

B. 7 and *G.* 7. This school is said to be of the same type as *B.* 11 and *G.* 11. Much attention has been paid to physical exercises and organized games, resulting in marked benefit to the physique of the children.

B. 8 and *G.* 8. This school is a little below the general average. The parents are artizans, mechanics, and are employed in gas-works, and on the whole have fairly steady work. The attendance is good and there is little sickness among the children, who live within easy distance of large open spaces.

B. 9 and *G.* 9. This school is situated in one of the poorest districts of South London. The parents are mostly engaged in riverside work—watermen, dredgers, and casual labourers—and at the time of the inspection there was much unemployment in the district and many of the children were obviously underfed and very badly clothed. Many of the children are bootless even in winter. There is much overcrowding. The school is classed as one of special difficulty by the Education Committee of the London County Council.

B. 10 and *G.* 10. Except for the slum element which has lately been introduced by the building of cheap workmen's houses, the majority of the pupils are the children of small tradespeople, clerks, artizans, and shop assistants. The school is surrounded by open spaces and the children are under ideal conditions as regards fresh air and space for physical exercises and organized games. A good deal of time is devoted to hockey, cricket, football, and swimming, under the supervision of the teachers, with the result that a real *esprit de corps* exists among the pupils.

B. 11 and *G.* 11. This school is situated in a district where there is no overcrowding and is surrounded by many open spaces. The parents in most cases are in regular employment as small shopkeepers, clerks, gardeners, railway servants, and outdoor labourers.

G. 12. This school is situated in a district which is very mixed in character, streets of decent houses being close upon some of the worst slums, and consequently the class of children shows no uniformity. About half of the children come from fairly good homes and live under average conditions, but the proportion of poor and neglected children is steadily increasing.

G. 13. About 16 per cent. of the children in this school are extremely poor. At the time of the inspection there were between 30 and 40 children on the roll who lived in a slum close to the school. This, however, has now been demolished. There are a number of gardens and open spaces in the immediate neighbourhood, so that the school gets plenty of fresh air and sunshine.

B. 14. This school is situated in one of the poorest districts in London, and the

poverty is fairly uniform. From 30 per cent. to 40 per cent. of the children on the roll are given a free mid-day meal during the winter months. There are many cases of overcrowding. Most of the parents belong to the unskilled labour class, but there are few criminals.

These short notes will give some idea of the type of school in each case. They show that the schools differ widely in character and may fairly be considered as representative of the children of the elementary schools of London.

(3) Categories Used.

In determining categories for qualitative classification it is essential that the terms used should be defined as clearly and definitely as possible, and, further, that the definitions selected should be tested by actual practice,* so that the personal equation of the observers may be reduced to a minimum. The use of the word "average" in the categories is to be deprecated, as it does not mark, except in very inexact language, a class, but a definite degree, and where we find 50 per cent. of the children classed as "average", 20 per cent. as "above", and 17 per cent. as "below" the average, the remaining 13 per cent. being put in extreme classes above "above" and below "below" the average, there must arise some danger of a large personal equation, and therefore some difficulty in distinguishing its effects from true environmental effects.

Not only is there some vagueness in the categories used, but, as will be seen when we deal with the various characters, the system used varies considerably in different schools.

For every child there is given a statement of the age, standard, height, and weight, and an estimate by the teacher of the child's mental capacity, while the medical officers give for the children in every school an estimate of the condition of the teeth, in 8 boys' schools and 9 girls' schools an estimate of the state of nutrition, of the condition of the clothing in 7 boys' schools and 6 girls' schools, of the degree of cleanliness in 6 boys' schools and 6 girls' schools, and of the power of hearing, condition of the cervical glands and condition of the tonsils and adenoids in 3 boys' schools and 3 girls' schools.

In all, 4,286 boys and 4,474 girls are dealt with.

(4) Classification of Intelligence.

Since the main purpose of our investigation is to discuss the effect of various physical conditions on the intelligence of the children, it will be convenient to consider first of all the teachers' estimate of the mental capacity of the children.

Five grades of mental capacity were used: one mark being given to a "very dull and backward" child, two marks to a child "below the average", three marks

* For example, by two observers examining the same group of children independently.

to an "average" child, four marks to a child "above the average", and five marks to a child who could be called "brilliant".

The percentages of children in each school who were placed in each grade of mental capacity are given in Table II.

TABLE II.

THE PERCENTAGE OF CHILDREN IN EACH GRADE OF MENTAL CAPACITY IN EACH SCHOOL.

School Number.	Boys.					School Number.	Girls.				
	Grade of Mental Capacity.						Grade of Mental Capacity.				
	Brilliant.	Above the Average.	Average.	Under the Average.	Very Dull and Backward.		Brilliant.	Above the Average.	Average.	Under the Average.	Very Dull and Backward.
1	33	35	24	8	—	1	33	22	22	19	4
2	4	13	59	17	7	2	1	11	69	15	3
3	9	24	44	18	5	3	3	13	62	17	5
4	3	15	61	21	—	4	2	16	69	12	1
5	16	24	47	13	1	5	15	30	37	14	4
6	3	19	44	31	3	6	4	19	58	18	2
7	3	23	50	18	5	7	1	17	41	31	10
8	11	44	34	9	2	8	5	33	49	11	1
9	5	17	39	27	11	9	22	27	38	10	3
10	5	17	57	19	2	10	7	18	60	13	3
11	13	27	47	9	5	11	9	28	40	16	7
12	—	—	—	—	—	12	—	4	82	13	1
13	—	—	—	—	—	13	1	9	68	18	4
14	11	23	43	22	2	14	—	—	—	—	—

This table indicates quite clearly that the estimation by the teachers of the mental capacity of the children on this system is far from satisfactory. We find, for example, that the percentage of children who are classed as "brilliant" varies from 3 per cent. to 33 per cent. among the boys, and from 1 per cent. to 33 per cent. among the girls, while in one boys' school which was not used exactly 50 per cent. of the children were classed as "brilliant", and in Standard III of that school, out of a class of 95, no fewer than 83 were marked "brilliant".

These differences seem much greater than could possibly arise from any real differences between the average intelligence of children in different districts of London, and what is more, the percentages may differ considerably in the boys' and girls' departments of the same school. In School No. 9, for instance, while 22 per cent. of the girls are marked "brilliant", only 5 per cent. of the boys get this mark.

It is desirable that we should be able to express the degree of heterogeneity among the different schools by a single number. To do so we must use Professor Pearson's "Coefficient of Class Heterogeneity".* To find this coefficient we

* See *Biometrika*, vol. v, p. 198.

must form a contingency table, in which the rows are the distributions of mental capacity in each school, so that in the case of the boys we have a five × twelve-fold contingency table, and in the case of the girls a five × thirteen-fold contingency table. If now the contingency coefficients be calculated from these tables, we have two numbers which express the degree of heterogeneity among the boys' and girls' schools respectively.

If the proportions in each grade of mental capacity were the same for all the schools, then this coefficient would be zero, while the maximum amount of divergence would be represented by a coefficient of unity, and the higher the coefficient the greater the degree of heterogeneity.

Actually those coefficients were found to be:

For the Boys' Schools, ·37.
For the Girls' Schools, ·45.

In the face of such divergence as is represented by these numbers we are compelled to assert that either the schools, and each department of the schools, represent highly differentiated grades of intelligence, or that there has been far too much scope left for the play of personal equation. There can be little doubt that personal equation and not local differentiation contributes the bulk of the heterogeneity. No conventional use of the word "brilliant" would admit of our returning 33 per cent. of the scholars—even in a middle-class scholarship preparatory school—as of "brilliant" intelligence. The word has evidently been used in a personal sense peculiar to the head master or mistress. We may be satisfied that the "brilliant" class in this school has intelligence of a higher grade than those classed as "above the average" in the same school, but it is clearly impossible to pool such estimates with those of another school in which the "brilliant" children form only 4 per cent., say, of the population.

It is clear that each school must be dealt with separately, and this immensely increases the labour of reduction and decreases the certainty of and weight to be given to our conclusions. Believing that the heterogeneity above measured is principally due to personal equation, it will not be without interest to observe how far the individual schools differ from the average of all schools in the use of the terms employed by the teachers, by estimating the relative heterogeneity of the individual schools.

To do so we must form a contingency table consisting of two rows only, one row consisting of the mental capacity distribution of a single school, and the other row, of the distribution of all the other schools taken together. The contingency coefficient found from this table gives a measure of the relative agreement of the individual schools with the general "norm". These coefficients are given in Table III.

TABLE III.

Coefficients of Divergence for Individual Schools.

School Number.	Coefficient of Divergence.	
	Boys.	Girls.
1	·25	·28
2	·09	·08
3	·02	·08
4	·11	·12
5	·08	·13
6	·09	·06
7	·09	·19
8	·15	·11
9	·14	·16
10	·07	·03
11	·09	·10
12	—	·20
13	—	·11
14	·05	—
Mean	·10	·13

This table confirms what has already been found from Table II, that the estimation by the teachers of the mental capacity of the children has not been reduced to any standard value. In all probability this is due to the fact that a system of marks such as that adopted and the rather loose categories " average ", "under the average", &c., which they represent, did not demand sufficient preliminary thought on the part of the teachers.

Much better results were obtained by Professor Pearson's more elaborate and more definite scale of mental capacity.* But it must be remembered that in Professor Pearson's investigation, all those who sent in returns were volunteers, and the bulk of them secondary school teachers, while in the present case the return was compulsory and was probably resented by a few as an extra, and perhaps in their opinion an unnecessary duty. It is probable also that some teachers imagined that to enter any children as " very dull and backward " would in some way or other be to their disadvantage. A little consultation, however, between head master or head mistress and the members of the staff, followed by a slight examination of the returns, would probably have eliminated some of the greater divergences.

It will be seen at once that from this standpoint this pioneer survey has a most valuable lesson to teach us. There must be a preliminary standardization of the teachers who are called upon to estimate the intelligence of their pupils. It is idle to assert that there is no such thing as " general intelligence " ; it may be difficult to find a satisfactory means of measuring it, but measure it we must if we are to obtain any useful facts from these school surveys. In the battle of life

* *Biometrika*, vol. v, p. 107.

it is general intelligence which grades men, and that is what we seek to measure, imperfectly it may be, by the system of examinations or in practical affairs by our experience of men. Under a good system of closely defined categories we believe that two experienced teachers will show only a small percentage of divergence in classifying pupils with whose work they have been familiar for some time. But even without this system, would not the results of general examinations for each standard provide a better test of general intelligence than we have had to deal with above? It is usual in this country for a child to advance a standard a year, and the place in the standard is usually known each year by examination. We might therefore propose to adopt as our standard the grade of the child, i.e. $100 \times$ place in standard $\div$ number examined. This would require correction for age, but this correction might be made once for all by ascertaining the correlation for the same standard between place and age. Thus a child's intelligence would be measured by the deviation of its grade in the standard from the mean grade of children of that age in the standard. This would very considerably reduce the personal equation, especially in the case of teachers who are not apt psychological observers. Some day we may hope that examinations may be skilfully devised for the very purpose of grading the intelligence of school children; these examinations would be accompanied by various psychological tests, but we are somewhat removed from this at present, and also from being able to base a satisfactory measure of general intelligence even on the results of such mental tests, if they were made. The wisest course at present seems to be to determine place in standard, corrected for age, and compare this with the teacher's estimate of the intelligence of the children obtained by carefully defined verbal categories.

(5) General Scale of Intelligence.

Even with such heterogeneous material, however, there is some advantage to be gained by a study of the distribution of the mental capacity of all the children of the same sex together. The numbers and percentages of boys and girls in each grade of intelligence are given in Table IV.

TABLE IV.

The Numbers and Percentages in Five Grades of Mental Capacity.

Mental Grade.	Boys.		Girls.	
	Number.	Percentage.	Number.	Percentage.
Brilliant	419	10	351	8
Above the Average	1,036	24	853	19
Average	1,941	45	2,357	53
Under the Average	741	17	737	16
Very Dull and Backward	149	3	176	4
Total	4,286		4,474	

It will be seen that the percentages of "brilliant" and "above the average" boys are somewhat higher than in the case of the girls, but the differences are small and not necessarily significant.

If we now make the assumption that mental capacity follows the normal or Gaussian curve of errors, it is possible to express this qualitative scale in quantitative form. Taking first of all as our unit the standard deviation of mental capacity, σ, we can find the range of each grade of intelligence, the whole range extending from $-\infty$ to $+\infty$. The results are given in Table V, and we see that in the case of the boys the "brilliant" group extends from $+\infty$ to $+1{\cdot}294\,\sigma$, the group "above the average" from $+1{\cdot}294\,\sigma$ to $+{\cdot}414\,\sigma$, the "average" group from $+{\cdot}414\,\sigma$ to $-{\cdot}815\,\sigma$, and so on.

TABLE V.

RELATIVE SCALES OF MENTAL CAPACITY WITH THE STANDARD DEVIATION AS UNIT AND WITH MEANS SUPPOSED TO BE IDENTICAL.

London County Council Schools.			Professor Pearson's Data.		
Class.	Boys.	Girls.	Class.	Boys.	Girls.
Median Individual.	·414 σ below top and ·815 σ above bottom of "Average" Group.	·616 σ below top and ·827 σ above bottom of "Average" Group.	Median Individual.	·113 σ below top and ·733 σ above bottom of "Slow Intelligent" Group.	·007 σ below top and ·853 σ above bottom of "Slow Intelligent" Group.
Range of "Average".	1·229 σ	1·443 σ	Range of "Slow Intelligent".	·846 σ	·860 σ
			Range of "Slow".	·722 σ	·642 σ
Range of "Under the Average".	σ	·931 σ	Range of "Slow Dull".	·725 σ	·640 σ
Range of "Very Dull and Backward".	From 1·815 σ below median to ∞.	From 1·758 σ below median to ∞.	Range of "Very Dull".	From 2·180 σ below median to ∞.	From 2·135 σ below median to ∞.
Range of "Above the Average".	·880 σ	·8 σ	Range of "Intelligent".	1·108 σ	1·033 σ
Range of "Brilliant".	From 1·294 σ above median to ∞.	From 1·416 σ above median to ∞.	Range of "Quick Intelligent".	From 1·221 σ above median to ∞.	From 1·040 σ above median to ∞.

These results may now be compared with a similar distribution found for the school children of Professor Pearson's investigation, which has already been quoted. The results are given in the second part of Table V, and the results are also compared graphically in Fig. 1.

Such a method of comparison, however, assumes that the average intelligence in the two series is the same, and also the variability is the same; but there is no reason for supposing that this is the case. Each series is selected from the

Fig. 1. Relative Scales of Intelligence with Standard Deviation, σ, as Unit

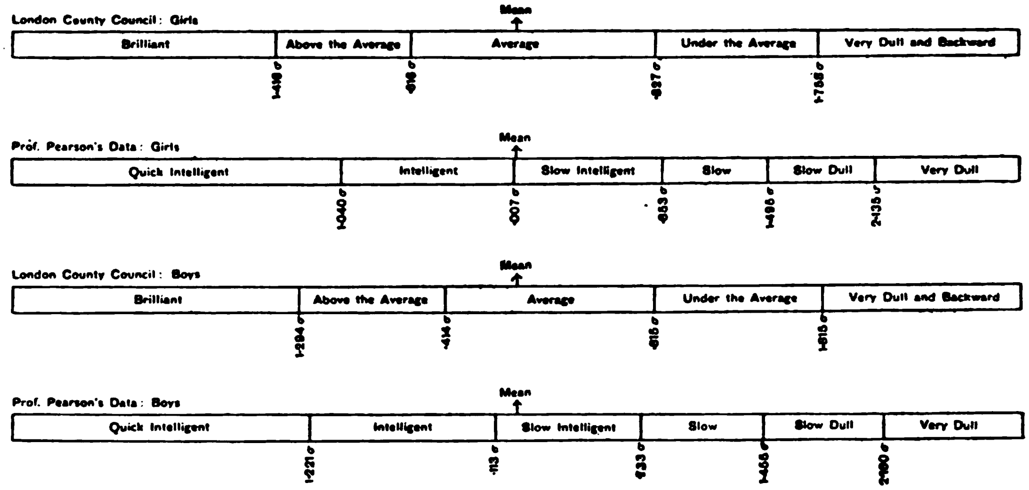


Fig. 2. Relative Scales of Intelligence with L.C.C. Group "Above the Average" and Pearson's "Intelligent" as Equivalents

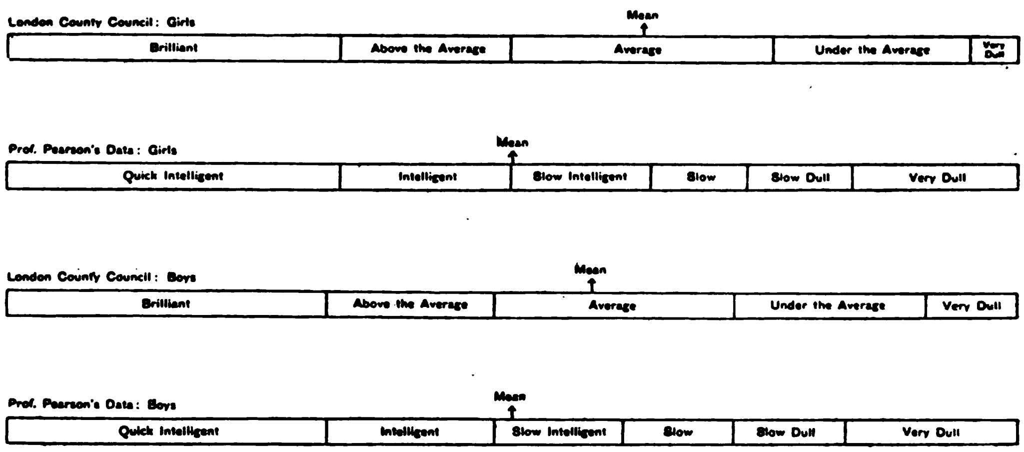
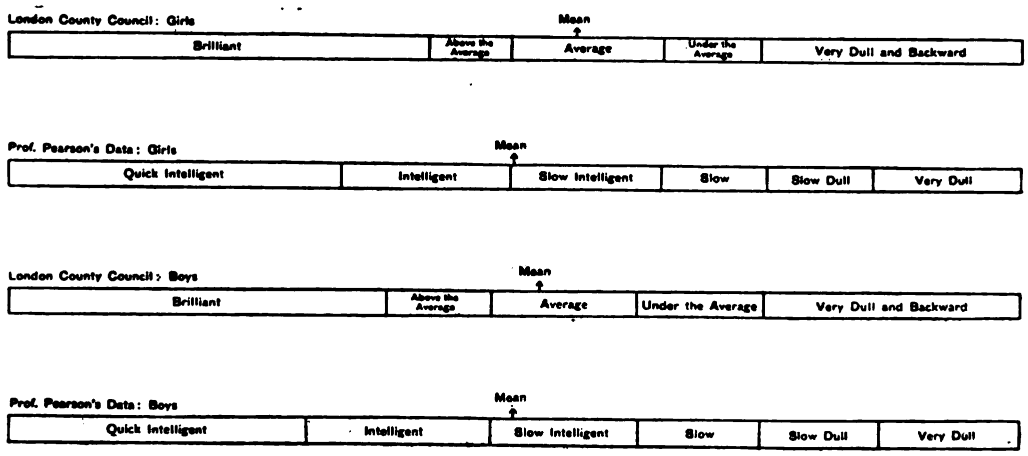


Fig. 3. Relative Scales of Intelligence with L.C.C. Group "Average" and Pearson's "Slow Intelligent" as Equivalents



total school children population of the country. Professor Pearson's data include many preparatory schools, with selected scholarship boys, some public schools and higher grade elementary schools in all parts of the country, and also includes some Scottish secondary schools, so that it is very probable that the average intelligence is greater than in the case of the London children, but it is not easy to say which series is the more variable.

A more satisfactory way of investigating the relative intelligence of the two series is to suppose equality in the range of some of the categories.

TABLE VI.

RELATIVE SCALES OF MENTAL CAPACITY WITH THE "ABOVE THE AVERAGE" GROUP AND "INTELLIGENT" GROUP AS EQUIVALENTS.

London County Council Schools.			Professor Pearson's Data.		
Class.	Boys.	Girls.	Class.	Boys.	Girls.
Median Individual.	·470 below top and ·926 above bottom of "Average" Group.	·770 below top and ·827 above bottom of "Average" Group.	Median Individual.	·102 below top and ·662 above bottom of "Slow Intelligent" Group.	·007 below top and ·826 above bottom of "Slow Intelligent" Group.
Range of "Average".	1·397	1·804	Range of "Slow Intelligent".	·764	·833
			Range of "Slow".	·652	·622
Range of "Under the Average".	1·136	1·164	Range of "Slow Dull".	·654	·620
Range of "Very Dull and Backward".	From 2·062 below median to ∞.	From 2·198 below median to ∞.	Range of "Very Dull".	From 1·1967 below median to ∞.	From 2·066 below median to ∞.
Range of "Above the Average".	1·000	1·000	Range of "Intelligent".	1·000	1·000
Range of "Brilliant".	From 1·470 above median to ∞.	From 1·770 above median to ∞.	Range of "Quick Intelligent."	From 1·102 above median to ∞.	From 1·007 above median to ∞.

In Table VI and in Fig. 2, I have compared the two series on the assumption that the group "above the average" in the case of the London children is the same as the group "intelligent" in Professor Pearson's investigation. We see that the agreement is much closer than before and that we have now some correspondence between the two series. The "average" group has now substantially the same range as the two groups "slow intelligent" and "slow" in Professor Pearson's data. Such a basis of comparison also allows for a considerable difference between the average intelligence in the two series, a result which has already been stated to be very probable.

The only difficulty about this basis of comparison is that it makes the "brilliant" group of the London children equal in range to Professor Pearson's "intelligent" group. Now we see from Table II that in one school as many as 30 per cent. of the children are marked "brilliant", so that the term is applied somewhat freely. If, however, we take a third basis of comparison and make the groups "average" and "slow intelligent" equal in range we get over this difficulty. The result is shown in Fig. 3, and the agreement is now quite satisfactory. The group "brilliant" is now seen to cover about half of the "intelligent" group in addition to the "quick intelligent" group, "under the average" is nearly equal to "slow", and "very dull and backward" has practically the same range as the two groups "slow dull" and "dull".

No very great stress, however, can be laid on any such schemes because of the high personal equation of the teachers; their object is to show the essential importance of a common standard of ability which may be used for comparative purposes in schools of all classes.

We shall use this general scale to illustrate graphically various points, but in the main we must depend upon the examination of the results for individual schools and endeavour to disentangle significant values from the large errors of small samples.

(6) Relationship of Intelligence to Other Characters.

We can now proceed to the main part of the inquiry and investigate the relationships which exist between mental capacity and the other characters tabulated. These relationships have been worked out in various ways. When both characters are quantitative, e. g. when dealing with the relationships between height, weight, and age, the correlation coefficients have been obtained by the ordinary product moment method. This assumes, of course, that the regression is linear, and where age is concerned this is not strictly true, but the divergence from linearity is small and we obtain results which are sufficiently accurate for our present purpose. When one of the characters is quantitative and the other qualitative we can make use of the correlation ratio, and when the qualitative scale consists of two groups only, Professor Pearson's new method of determining correlation was used.* When both characters are qualitative, contingency tables were used, if at least a three × threefold division of the material could be made; otherwise fourfold tables were used.

* W. Palin Elderton's *Frequency Curves and Correlation* (C. & E. Layton) can be recommended as an excellent introduction to modern statistical methods. Nearly all the processes employed in this paper are illustrated there. For the correlation ratio, see Professor Pearson's *General Theory of Skew Curves and Non-linear Regression*, Drapers' Company Research Memoirs, Biometric Series II (Dulau & Co.); and for the new method of determining correlation indicated above see Professor Pearson's paper in *Biometrika*, vol. vii, p. 96.

Considerable difficulty was experienced in determining the signs of the correlation when contingency coefficients were used. The simplest method is to arrange the contingency table in fourfold form and then assign to the correlation, numerically measured by the contingency coefficient, the sign which would be obtained from the fourfold table. But in many cases, the material is so rough that by changing the lines of division different signs can be obtained. To obtain a unique solution, that division into fourfold form was chosen which most nearly gave four equal compartments. Even this, however, was not always sufficient; in two cases such a division gave zero correlation from the fourfold table, and as the contingency coefficient was not zero in those cases, another method of division had to be used.

This happened, for instance, in the case of *G.* 10, in the table giving the relationship between mental capacity and the condition of the teeth. The original contingency table is given in Table VII, but when we express this in fourfold form,

TABLE VII.

G. 10. THE RELATIONSHIP BETWEEN MENTAL CAPACITY AND THE CONDITION OF THE TEETH.

		Mental Capacity.					
		I	II	III	IV	V	Totals.
Condition of the Teeth.	II	1	1	5	—	—	7
	III	—	3	29	9	4	45
	IV	3	10	39	8	4	64
	V	1	7	27	13	4	52
	Totals.	5	21	100	30	12	168

by taking together groups I + II + III and IV + V in the case of mental capacity, and groups II + III and IV + V in the case of the condition of the teeth, and so obtain Table VIII, the resulting correlation coefficient is zero, and we must take the next

TABLE VIII.

TABLE VII ARRANGED IN FOURFOLD FORM SO AS TO GIVE ZERO CORRELATION.

		Mental Capacity.		
		I + II + III	IV + V	Totals.
Condition of Teeth.	II + III	39	13	52
	IV + V	87	29	116
	Totals.	126	42	168

best division by taking II+III+IV together and V alone for the condition of the teeth, and so obtain Table IX, which gives a positive correlation coefficient.

TABLE IX.

ALTERNATIVE ARRANGEMENT OF TABLE VII.

		Mental Capacity.		
		I+II+III	IV+V	Totals.
Condition of Teeth.	II+III+IV	91	25	116
	V	35	17	52
	Totals.	126	42	168

The same difficulty was experienced when dealing with the correlation ratio. Like the contingency coefficient it has by its very nature *no* sign, but when it is used as equivalent to a correlation coefficient we must determine what sign the corresponding correlation coefficient would have. In every case the regression line was plotted from the means of the arrays, and in most cases this was sufficient to determine the sign; but here also cases arose which seemed indeterminate, and in such cases the material was divided as equally as possible into two columns, and the slope of the regression line found from these was used to determine the sign of the correlation coefficient, whose *numerical* value was obtained from the correlation ratio.

It ought also to be stated that a *positive* sign has been given throughout when a *greater* value of a quantitative character was associated with a *better* value of a qualitative character, or when the better values of two qualitative characters were associated; thus, when intelligence was found to increase with age, or when the condition of the teeth was found to improve with age; when good hearing was associated with a bad condition of the tonsils and adenoids, a negative sign was given.

Although most of the contingency coefficients found are significant, only 5 out of 59 exceed ·25; but the distribution of magnitudes has a distinctly bimodal form. The actual distribution is given in Table X and graphically in Fig. 4. It

TABLE X.

DISTRIBUTION OF MAGNITUDE OF 59 CONTINGENCY COEFFICIENTS INDICATING THE RELATIONSHIP BETWEEN MENTAL CAPACITY AND PHYSICAL CONDITION.

Magnitude . . .	−·2	−·1	0	+·1	+·2	+·3	+·4	Total
Frequency . . .	6	9	1	16	22	4·5	·5	59

FIG. 4. FREQUENCY DISTRIBUTION OF 59 CONTINGENCY COEFFICIENTS BETWEEN MENTAL CAPACITY AND PHYSICAL CONDITION.

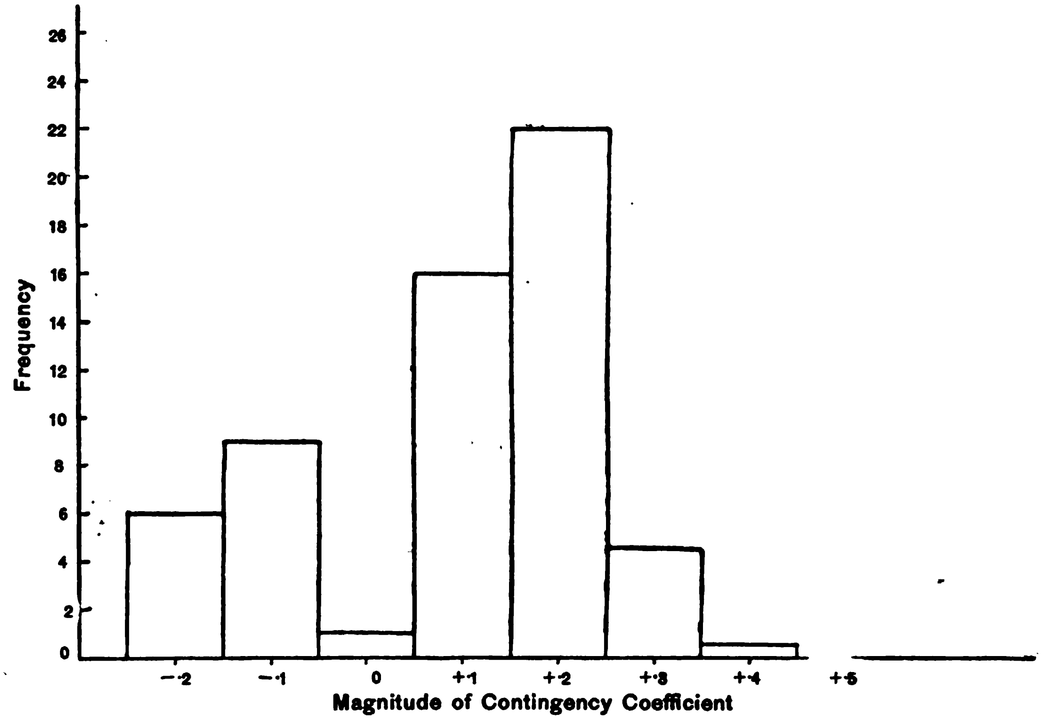
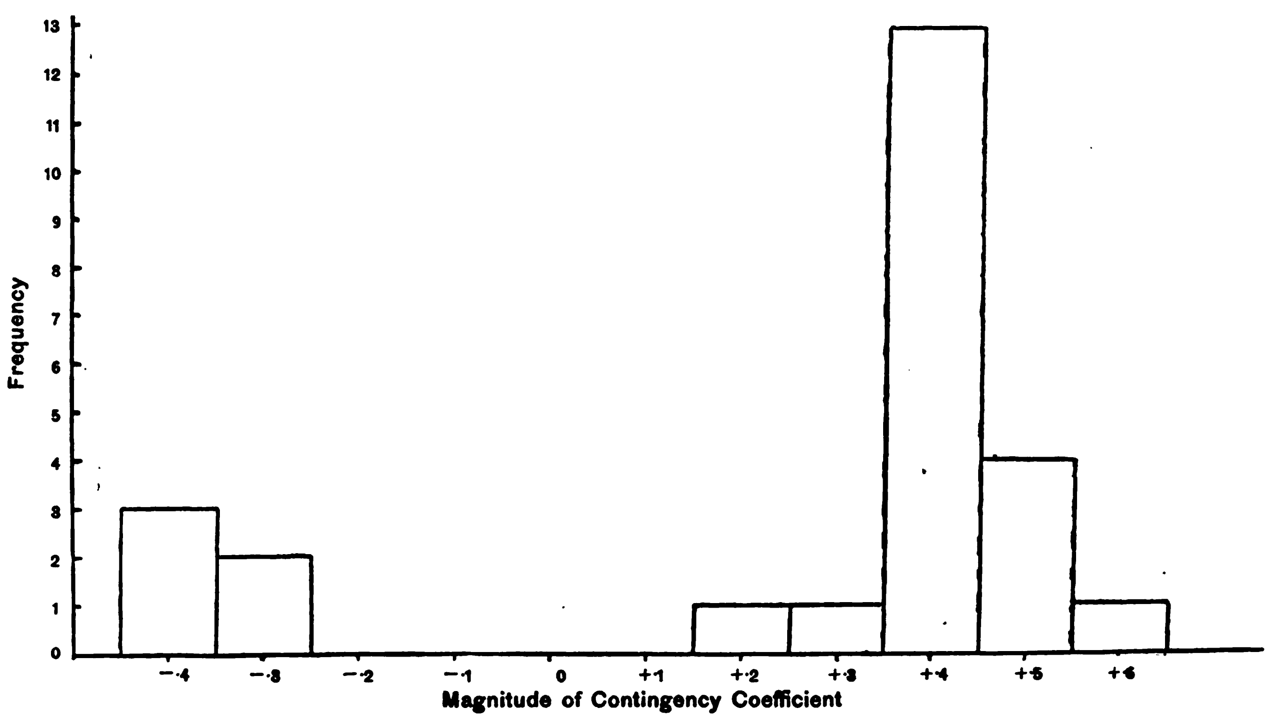


FIG. 5. FREQUENCY DISTRIBUTION OF 25 CONTINGENCY COEFFICIENTS BETWEEN MENTAL CAPACITY AND STANDARD.



will be seen that the distribution consists of two parts, one containing positive contingency coefficients and the other negative contingency coefficients. The bimodal form of the distribution of contingency coefficients is even more clearly shown in Table XI and Fig. 5, which give the relationship between the standard

TABLE XI.

DISTRIBUTION OF MAGNITUDE OF 25 CONTINGENCY COEFFICIENTS INDICATING THE RELATIONSHIP BETWEEN STANDARD AND MENTAL CAPACITY.

Magnitude . .	−·4	−·3	−·2	−·1	0	+·1	+·2	+·3	+·4	+·5	+·6	Total
Frequency . .	3	2	—	—	—	—	1	1	13	4	1	25

and mental capacity for 25 schools. The roughness of the material and the personal equation of the observers seem to increase the contingency coefficients. One would naturally expect a positive correlation between mental capacity and standard, and the existence of five negative correlations must indicate personal equation of teachers, i. e. teachers of low standards have been optimistic and those of high standards have been pessimistic, and they have labelled their children accordingly. The existence of negative correlations between mental capacity and physical conditions may also be due to personal equation; it is quite probable that some teachers have confused "intelligence" with orderly behaviour and quietness, and so have classed some of the weaklings as "intelligent", while the physically active and noisy children were regarded less favourably.*

In view of those difficulties we can only use the average of the values found for individual schools as giving some measure of the actual relationship, and cannot lay any stress on individual results, so long as we have so many evidences of irregularity due to personal equation.

(7) THE RELATIONSHIP BETWEEN MENTAL CAPACITY AND AGE.

Dealing first of all with the individual schools, we find the 25 correlation ratios given in Table XII. It will be noticed that here also we have considerable positive and negative values, which may occur in the same school, e. g. see Schools Nos. 4 and 5, while the average among both boys and girls is very small. It is not possible to assert on the basis of this table that any definite relationship exists between mental capacity and age. This is strictly in accordance with the results found by Professor Pearson: For boys, $\eta = \cdot 05 \pm \cdot 01$; For girls, $\eta = \cdot 08 \pm \cdot 01$ † where the relationship, though significant, is very small.

* The high correlation found in some cases between mental capacity and standard may in part be due, as Dr. Kerr suggests, to the fact that from the age 7 to age 11, 0·8 % of children are weeded out and sent as mentally defective to special schools. A trace of this is probably noticeable in Fig. 6, p. 24.

† Throughout this paper, when the correlation is obtained by the product moment method, the probable error is calculated by the usual formula; in other cases to determine significance it is calculated on the basis of zero correlation.

TABLE XII.

THE RELATIONSHIP BETWEEN AGE AND MENTAL CAPACITY.

School Number.	Correlation Ratios.	
	Boys.	Girls.
1	$+\cdot03\pm\cdot04$	$-\cdot26\pm\cdot04$
2	$+\cdot21\pm\cdot04$	$+\cdot12\pm\cdot05$
3	$+\cdot07\pm\cdot03$	$+\cdot26\pm\cdot04$
4	$+\cdot24\pm\cdot04$	$-\cdot18\pm\cdot03$
5	$+\cdot27\pm\cdot04$	$-\cdot28\pm\cdot03$
6	$-\cdot20\pm\cdot03$	$+\cdot19\pm\cdot04$
7	$+\cdot13\pm\cdot03$	$-\cdot27\pm\cdot03$
8	$+\cdot08\pm\cdot04$	$+\cdot17\pm\cdot04$
9	$+\cdot15\pm\cdot04$	$+\cdot16\pm\cdot04$
10	$+\cdot11\pm\cdot04$	$+\cdot29\pm\cdot05$
11	$-\cdot23\pm\cdot03$	$-\cdot12\pm\cdot03$
12	–	$-\cdot11\pm\cdot03$
13	–	$+\cdot14\pm\cdot04$
14	$-\cdot16\pm\cdot04$	–
Mean	$+\cdot06$	$+\cdot05$

We can also look at the matter in another way by finding the average age of all the boys and all the girls in each grade of mental capacity. These averages with their probable errors are given in Table XIII, and the table shows that there is no significant difference between the average ages of the children in the different intelligence groups.

TABLE XIII.

THE RELATIONSHIP BETWEEN AGE AND MENTAL CAPACITY.

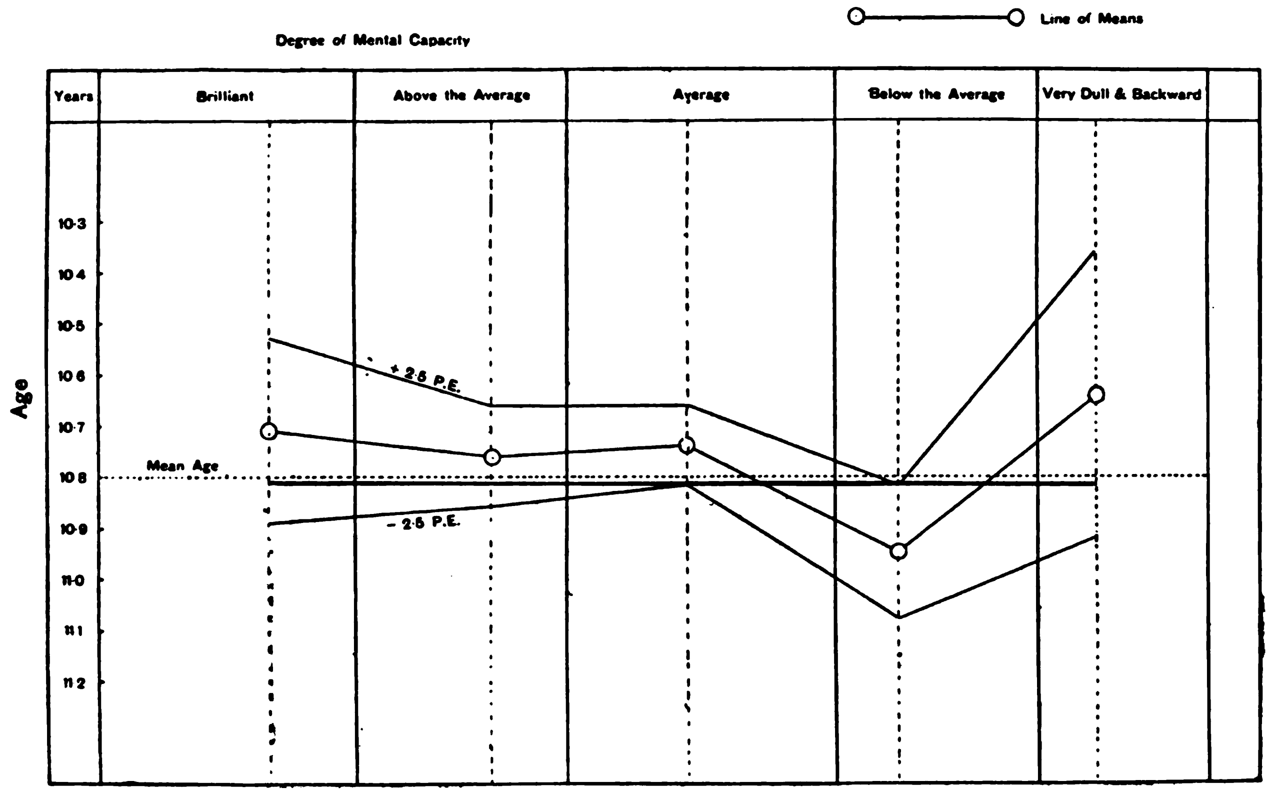
MEAN AGES OF CHILDREN, IN FIVE GROUPS OF MENTAL CAPACITY.

Mental Group.	Mean Ages: Boys.	Mean Ages: Girls.
Brilliant	$10\cdot71\pm\cdot07$	$11\cdot05\pm\cdot08$
Above the Average . . .	$10\cdot76\pm\cdot04$	$11\cdot04\pm\cdot05$
Average	$10\cdot74\pm\cdot03$	$11\cdot14\pm\cdot03$
Under the Average . . .	$10\cdot95\pm\cdot05$	$11\cdot05\pm\cdot05$
Very Dull and Backward .	$10\cdot64\pm\cdot11$	$10\cdot98\pm\cdot11$.
All groups	$10\cdot80\pm\cdot02$	$11\cdot10\pm\cdot02$

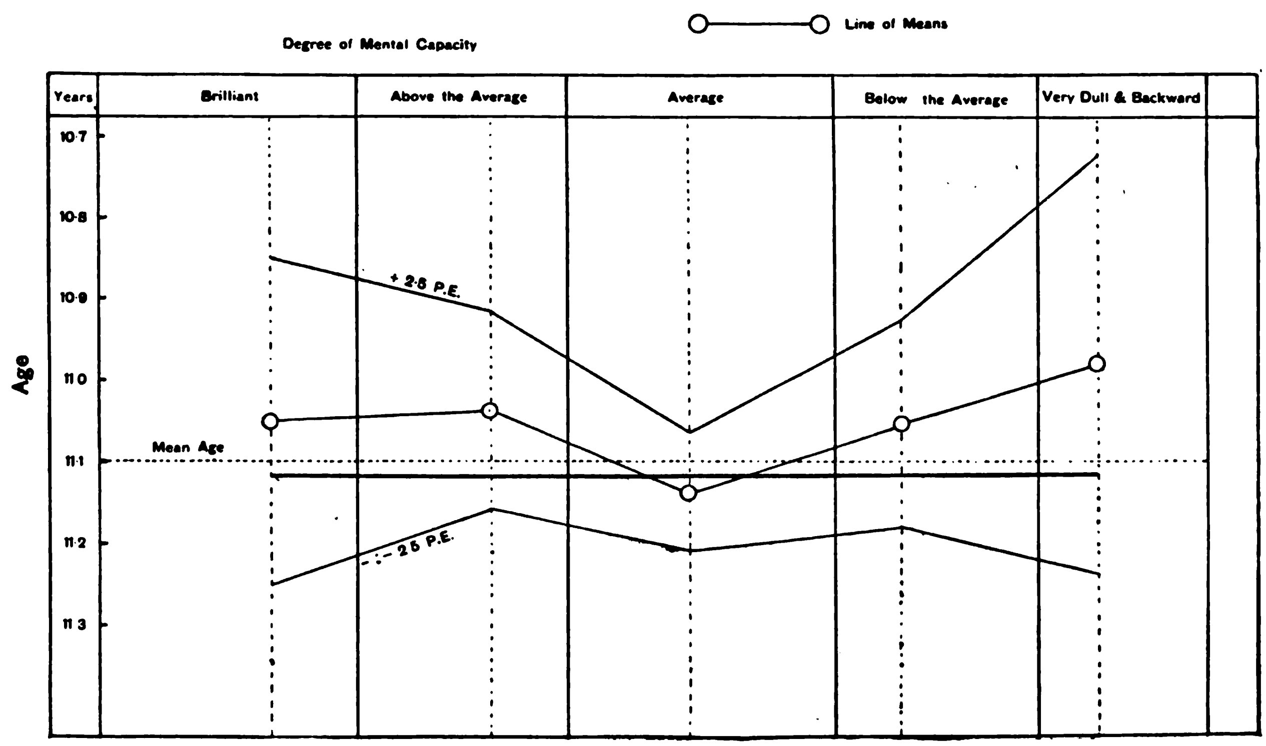
This is shown perhaps more clearly in Fig. 6. Lines are first of all drawn to indicate the average age of each intelligence group. Then above and below those lines are drawn two other lines at a distance of 2·5 times the probable error of each average. In the case of both boys and girls it is possible to draw a *horizontal* line which lies wholly within those bands, indicating clearly that there is no certain relationship between age and intelligence when we take the data in the bulk. The teacher's estimate of the mental capacity of a child ought of course to be relative to children of its own age, i. e. intelligence ought to be independent of age as has just been found.

FIG. 6. DIAGRAMS TO SHOW THAT, WITHIN THE LIMITS OF PROBABLE ERRORS, THERE IS NO RELATIONSHIP BETWEEN AGE AND MENTAL CAPACITY.

Boys: All Schools



Girls: All Schools



(8) The Relationships between Height, Weight, and Age.

We can now proceed to consider the growth curves of these children. In Tables XIV and XV I have given for boys and for girls the mean height of the

TABLE XIV.

Boys.—Mean Height in Centimetres at each Year of Age.

School Number.	Age.						
	8.	9.	10.	11.	12.	13.	14.
1	115·2	120·0	125·3	129·4	132·5	140·5	141·3
2	117·1	120·2	126·9	130·2	134·5	137·9	141·9
3	118·5	124·5	128·1	134·1	137·3	143·8	149·3
4	—	—	129·2	132·5	135·2	140·5	144·9
5	117·7	122·6	127·0	130·3	135·4	140·3	142·9
6	118·5	123·7	130·9	134·7	137·9	144·1	149·5
7	117·5	123·3	127·9	133·0	135·2	140·9	146·5
8	114·9	123·2	128·0	133·0	136·4	141·6	143·9
9	117·9	122·2	125·6	129·7	135·0	138·2	142·4
10	117·6	124·6	129·7	132·6	138·1	141·5	147·4
11	118·1	122·3	126·1	132·0	136·6	139·8	142·4
12	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—
14	114·0	118·3	124·5	127·0	133·4	137·0	—
Mean for all Boys.	117·1	122·3	127·3	131·6	135·7	140·7	145·0

Age 10 includes those between 9 years 6 months and 10 years 6 months.

TABLE XV.

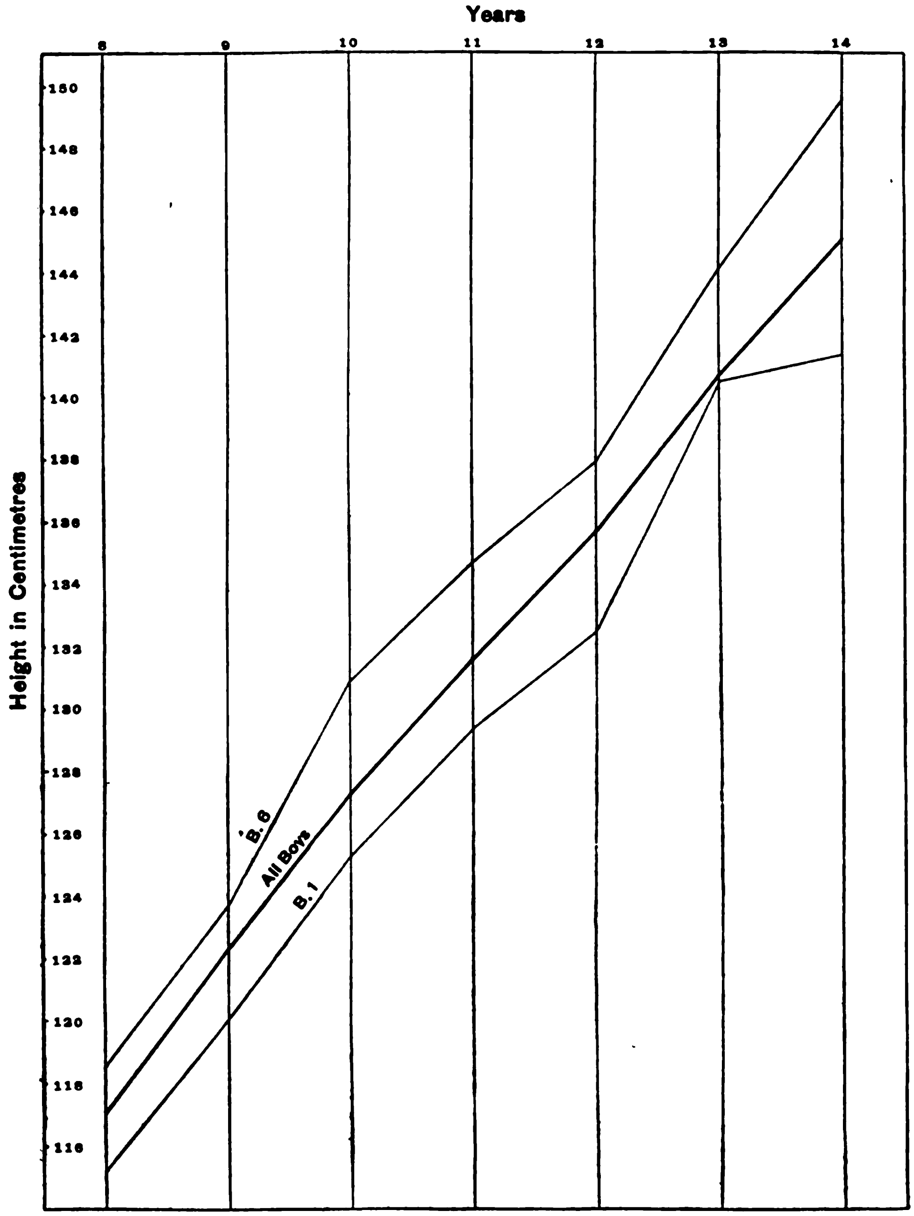
Girls.—Mean Height in Centimetres at each Year of Age.

School Number.	Age.						
	8.	9.	10.	11.	12.	13.	14.
1	115·6	120·0	124·9	129·1	133·6	139·9	145·8
2	117·7	122·9	124·2	130·3	136·1	142·0	145·9
3	119·2	123·4	128·5	133·9	139·9	147·0	149·5
4	117·1	121·3	126·2	131·9	138·1	142·8	147·9
5	116·0	120·6	124·4	130·2	136·4	141·5	144·2
6	118·8	123·9	129·9	132·9	139·2	144·3	150·8
7	118·0	121·9	126·7	132·3	137·4	144·7	147·7
8	117·7	122·9	126·8	132·8	137·1	143·8	147·2
9	116·8	121·4	126·1	129·9	136·8	141·9	146·5
10	117·8	122·0	128·9	134·6	139·0	144·1	—
11	115·3	120·5	125·4	128·9	136·5	139·9	145·0
12	120·2	121·4	126·6	132·7	137·0	143·2	148·7
13	121·1	122·3	125·2	128·7	136·2	143·1	145·0
14	—	—	—	—	—	—	—
Mean for all girls.	117·4	121·6	126·2	131·2	137·2	143·0	147·6

Age 10 includes those between 9 years 6 months and 10 years 6 months.

children in each school at each year of age, and the tables show very striking differences between the different schools. The probable errors are not given, but have been calculated, and in the extreme cases where the numbers of children on which the means are based are least, they in no case exceed half a centimetre,

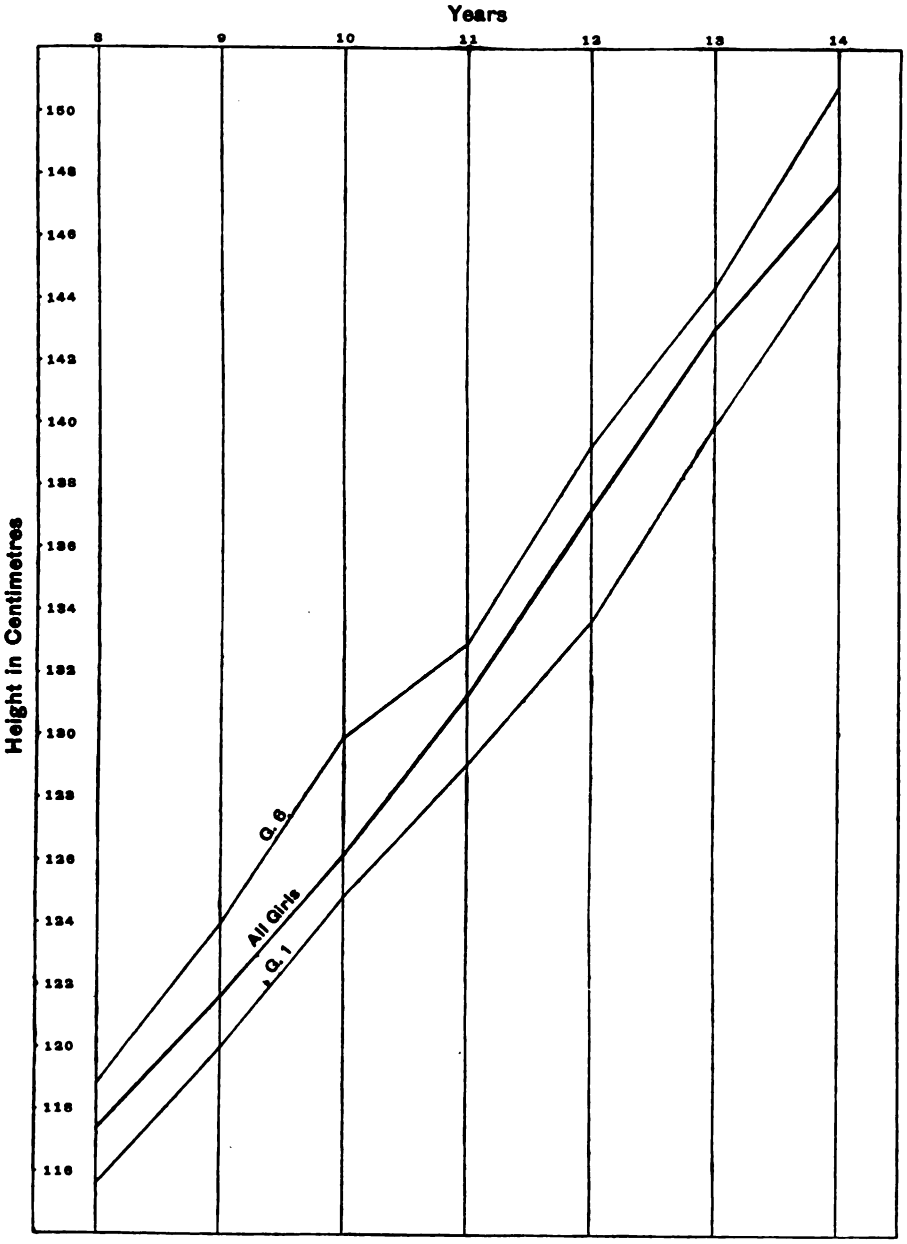
FIG. 7. DIAGRAM TO ILLUSTRATE THE HEIGHT OF L.C.C. BOYS.



so that the differences between the schools with tallest and shortest children is certainly significant. These extreme differences are shown graphically in Fig. 7, where I have plotted the mean height at each year of age for all boys, and also the mean heights in the "best" and "worst" schools so far as stature is concerned, while Fig. 8 gives similar graphs for the girls.

Similarly in Tables XVI and XVII we have the mean weight of the boys and girls in each school at each age, while in Figs. 9 and 10 the extreme differences between the "best" and "worst" schools are shown graphically.

FIG. 8. DIAGRAM TO ILLUSTRATE THE HEIGHT OF L.C.C. GIRLS.



How are we to account for those striking differences? I have already shown the danger of attributing them to purely environmental factors and of neglecting the influence of heredity, and have suggested that a consideration of the hair and eye colours of these children would go far towards settling the question. It has

TABLE XVI.

BOYS.—MEAN WEIGHT IN KILOGRAMS AT EACH YEAR OF AGE.

School Number.	Age. 8.	9.	10.	11.	12.	13.	14.
1	21·6	23·6	25·9	28·6	29·8	33·7	34·4
2	22·5	23·7	25·9	27·8	30·8	32·5	34·6
3	22·0	24·5	26·2	29·3	30·9	35·2	38·6
4	—	—	27·2	29·5	30·7	34·1	36·6
5	23·0	24·6	27·4	29·0	31·3	34·9	36·5
6	22·5	25·7	27·4	29·8	31·9	35·5	40·4
7	22·4	24·4	27·2	29·7	30·5	34·6	38·9
8	22·4	24·6	26·4	29·3	31·4	34·7	36·4
9	23·1	25·1	26·9	28·5	30·9	32·9	35·9
10	20·9	24·6	28·2	28·8	30·9	35·0	38·2
11	22·4	24·5	26·6	29·5	31·4	33·9	35·8
12	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—
14	21·6	24·7	25·5	26·8	30·2	32·1	—
Mean for all boys.	22·2	24·5	26·7	28·6	30·9	34·2	37·1

Age 10 includes those from 9 years 6 months to 10 years 6 months.

TABLE XVII.

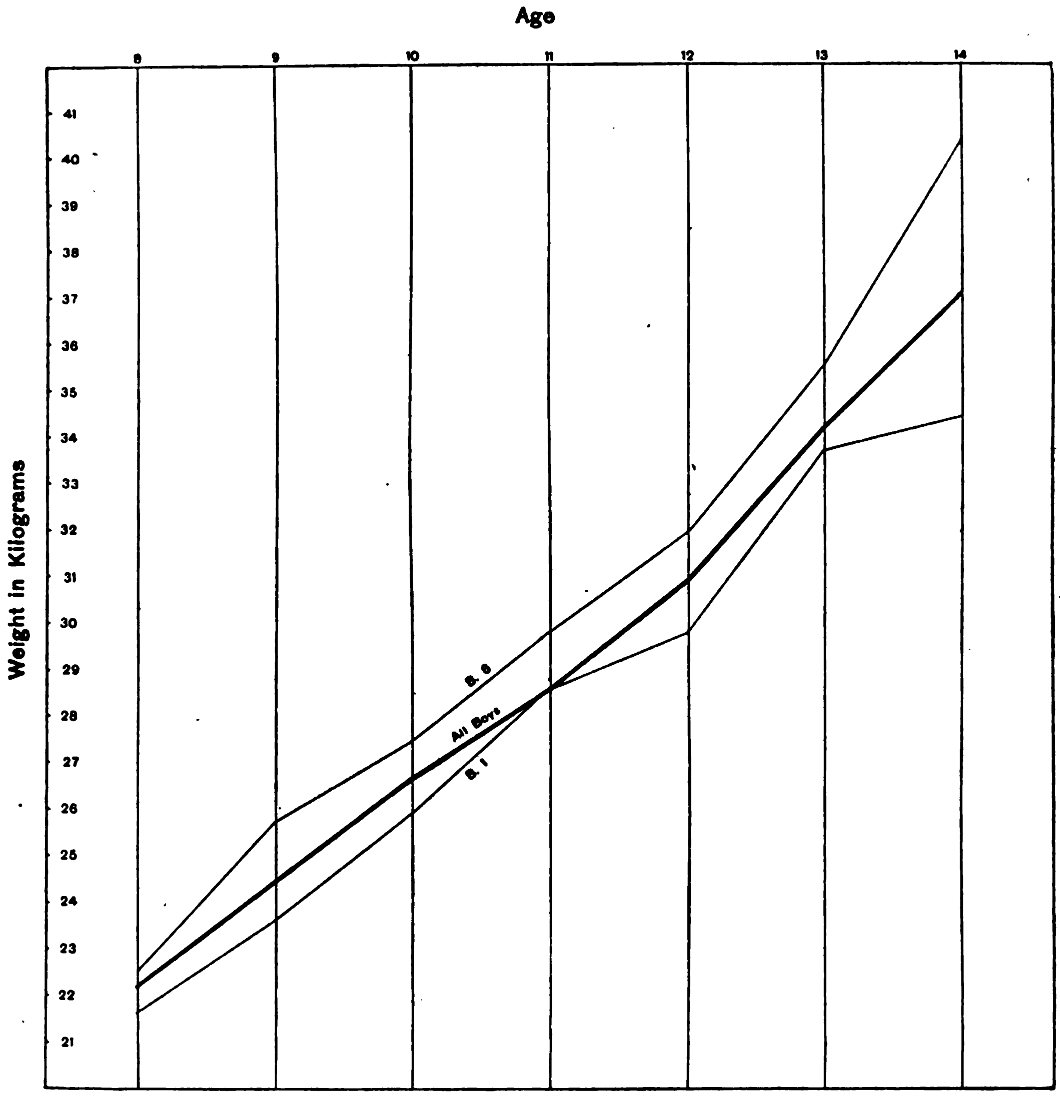
GIRLS' SCHOOLS.—MEAN WEIGHT IN KILOGRAMS AT EACH YEAR OF AGE.

School Number.	Age. 8.	9.	10.	11.	12.	13.	14.
1	22·4	23·5	26·0	27·8	30·5	34·7	38·5
2	21·9	23·8	25·1	27·7	31·3	34·7	35·4
3	21·5	22·7	24·8	28·0	32·3	36·4	39·0
4	21·6	23·7	26.2	28·7	32·8	36·0	42·5
5	22·1	23·7	25·6	29·3	32·0	35·9	37·5
6	21·2	24·3	27.4	28·8	33·1	36·0	40·6
7	22·1	24·3	26·0	28·8	31·2	36·9	38·2
8	21·8	23·7	25·7	28·1	32·3	35·2	39·9
9	21·8	23·7	26·3	28·0	31·3	34·6	37·8
10	23·1	23·7	26·8	29·2	32·4	35·8	—
11	21·3	23·6	26·4	28·2	31·7	34·8	37·2
12	22·8	23·7	26·1	28·8	31·5	35·7	40·0
13	23·4	24·2	26·4	27·5	31·2	35·6	36·2
14	—	—	—	—	—	—	—
Mean for all girls.	21·9	23·7	26·0	28·4	31·8	35·6	37·9

Age 10 includes those from 9 years 6 months to 10 years 6 months.

has already been pointed out that the racial differences between the various districts of London are very great, and that the fair-haired elements of the population are generally taller than the dark-haired elements, while Tocher has found very striking differences in the distribution of hair and eye colour in different districts

FIG. 9. DIAGRAM TO ILLUSTRATE THE WEIGHT OF L.C.C. BOYS.

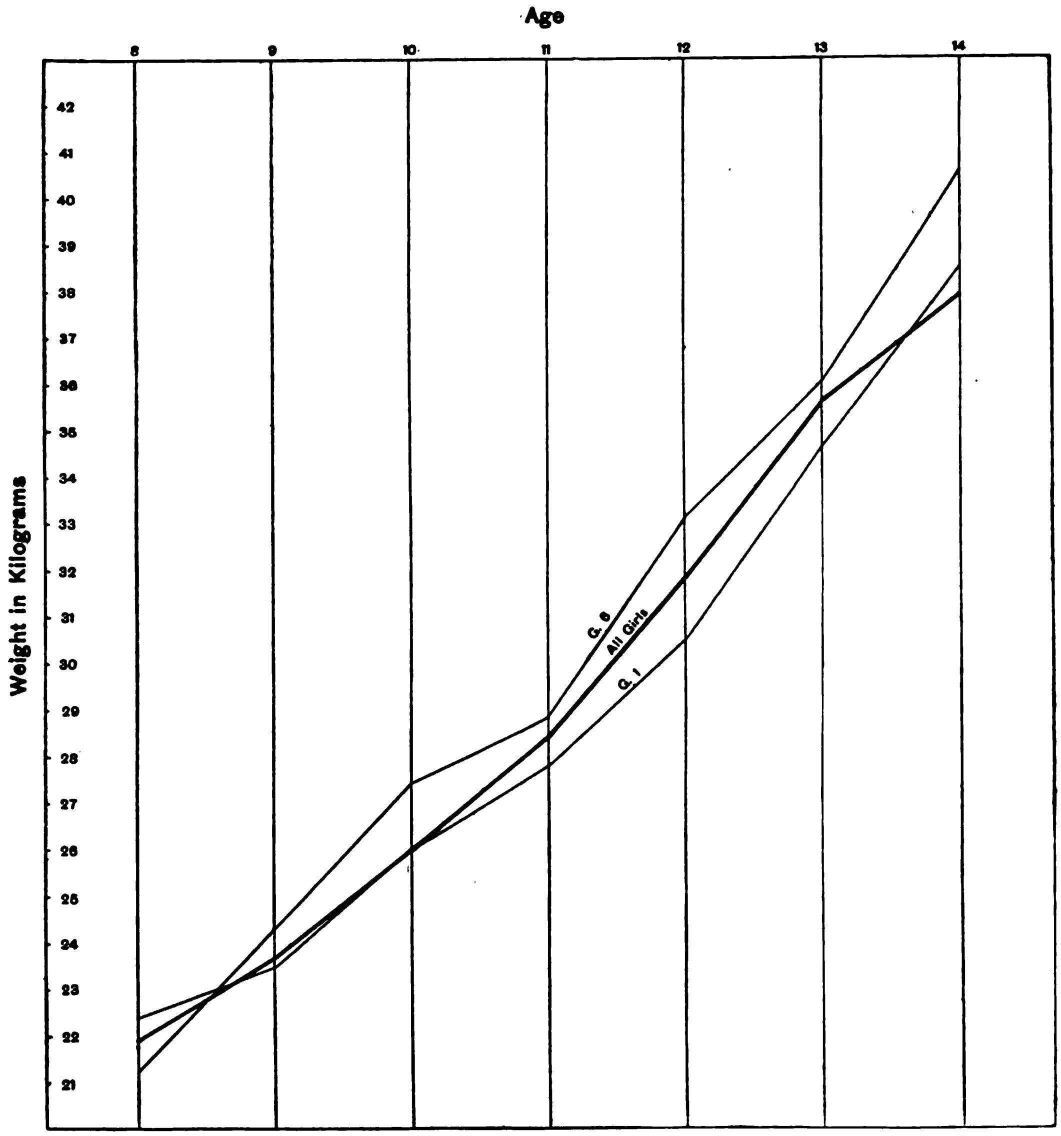


in Glasgow. It is therefore desirable that further surveys should include this very useful information.

We have seen that children of the same age from different districts of London differ very considerably in stature and weight. It is of some interest to consider the differences in weight between boys of the same stature. I have treated the matter graphically in Fig. 11. Taking the two boys' schools in which the children

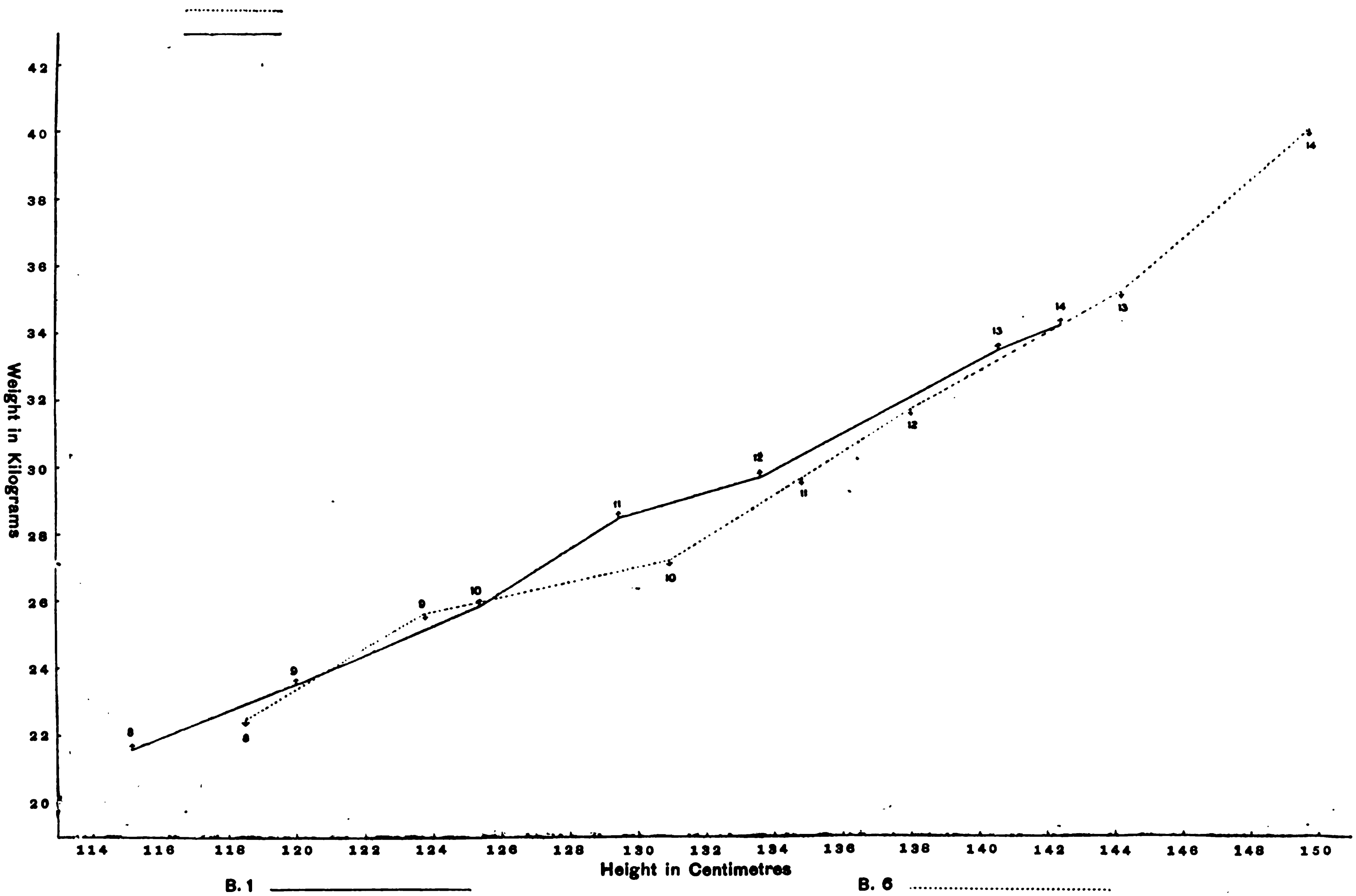
are on the whole tallest and shortest respectively, we can from Tables XIV and XVI obtain curves which give the relationship between height and weight in those schools. Now the diagram shows that both in stature and in weight the one school is practically a year ahead of the other, and yet for a given stature the

FIG. 10. DIAGRAM TO ILLUSTRATE THE WEIGHT OF L.C.C. GIRLS.



boys of the two schools are practically of the same weight; and if, as has been suggested, we measure the state of nutrition by the weight in proportion to the height, then the state of nutrition in the two schools is practically the same, and it would seem that the provision of free meals at school and other forms of charitable relief has been sufficient to bring the one school up to the level of the other as far as weight in proportion to stature is concerned.

Fig. 11. Diagram giving the Age, Height, and Weight of Boys in two selected Schools, B 1 and B 6. To show that, while for a Given Age, the Boys of B 6 are much Taller and Heavier than the Boys of B 1, for a Given Height they are practically equal in Weight.



In comparing the children of different schools in respect of height and weight, we obviously cannot put the average height of all the children of one school against a similar average for another school, unless the age distribution in the two schools is precisely the same, and in general that is not the case. In particular, when the social conditions of the children of two schools are widely different, it will be found that the age distributions of the two schools are also different; among the better class children the proportion of older children is higher because there is less tendency to leave school at the earliest possible age.

We must, then, as in Tables XIV to XVII, compare the heights and weights of children of the same ages. But it is so very convenient to have a single number to represent the stature of the children of all ages in a school, that the following method of obtaining a "School Height" is given, so that, instead of comparing eight or nine sets of means (according to the number of age groups used) we can deal with a single coefficient for each school.

The method by which the Registrar-General allows for differences of age distribution among men engaged in different occupations is well known; the occupational death-rates are based on a population with a "Standard Age Distribution", which is that of all occupied males. The death-rate among clergymen, for instance, is based, not directly on the number of deaths which occur among clergymen, but on the number of deaths which *would* occur if the age distribution among clergymen were the same as that of all occupied males.

An exactly analogous method can be used to obtain a single number to represent the mean height of a school; this may be called the "School Height". In all the schools under consideration let there be m_5 boys aged 5, m_6 boys aged 6, and so on, so that the age distribution of all boys is $M = m_5 + m_6 + \&c.$ In any individual school, let h_5 be the mean height of the boys aged 5, h_6 the mean height of all boys aged 6, and so on, then the individual "School Height" is given by

$$\text{S.H.} = \frac{m_5\, h_5 + m_6\, h_6 + \&c.}{\text{M}} = \frac{\Sigma mh}{\text{M}}$$

In exactly the same way, if w_5 be the mean weight of boys aged 5, then the "School Weight" is given by

$$\text{S.W.} = \frac{m_5\, w_5 + m_6\, w_6 + \&c.}{\text{M}} = \frac{\Sigma mw}{\text{M}},$$

and this principle can be extended to chest measurements, head measurements, or any quantitative measurements.

In the case of the London County Council Schools, the "School Heights" and "School Weights" were calculated for eleven boys' schools and thirteen girls' schools. School No. *B.* 4 was not used owing to there being no boys aged 8 included in the record.

The Standard Age Distributions on which those coefficients are based are given in Table XVIII.

TABLE XVIII.

STANDARD AGE DISTRIBUTIONS FOR L.C.C. SCHOOLS.

Age.	8.	9.	10.	11.	12.	13.	14.	Totals.
Boys .	130	159	169	145	144	156	97	1000
Girls .	106	147	176	160	159	152	100	1000

There appears to be a significant difference between the age distributions, but the results would not have been materially altered had the coefficients been based on an age distribution formed from the totals of both sexes, and we should have had the advantage of being able to compare directly boys and girls of the same school.

The values found for the "School Heights" and "School Weights" are given in Table XIX.

TABLE XIX.

"SCHOOL HEIGHTS" AND "SCHOOL WEIGHTS".

School Number.	School Heights (cms.).		School Weights (kgms.).	
	Boys.	Girls.	Boys.	Girls.
1	128·7	129·6	28·0	28·8
2	129·3	131·1	28·0	28·5
3	133·0	134·4	29·1	29·0
4	—	132·0	—	29·9
5	130.4	130·4	29·2	29·3
6	133·6	134·1	30·0	30·0
7	131·4	132·5	29·3	29·5
8	131·1	132·5	29·0	29·3
9	129·6	131·2	28·7	28·9
10	132·5	133·3	29·2	29·5
11	130·6	130·1	28·9	28·9
12	—	132·5	—	29·5
13	—	131·4	—	29·1
14	127·4	—	27·7	—

We see that the maximum differences are in the case of the boys 6·2 cms. and 2·3 kgms.; in the case of the girls they are 5·8 cms. and 1·5 kgms. These differences are certainly significant.

We can also look at the matter in another way. For ten schools we have the "School Heights" and "School Weights" both for boys and for girls. Let us arrange the schools according to the values given for "School Heights" and "School Weights" as shown in Table XX.

TABLE XX.

Place Order of Ten Schools for Height and Weight.

	Boys.		Girls.	
Order of Merit.	Height.	Weight.	Height.	Weight.
1	No. 6	No. 6	No. 3	No. 6
2	„ 3	„ 7	„ 6	„ 7
3	„ 10	„ 5	„ 10	„ 10
4	„ 7	„ 10	„ 7	„ 5
5	„ 8	„ 3	„ 8	„ 8
6	„ 11	„ 8	„ 9	„ 3
7	„ 5	„ 11	„ 2	„ 9
8	„ 9	„ 9	„ 5	„ 11
9	„ 2	„ 2	„ 11	„ 2
10	„ 1	„ 1	„ 1	„ 1

It is quite clear from this table that there is a close relationship between height and weight in the schools. No. 6 clearly stands at one end of the scale and No. 1 at the other. School No. 5 takes a higher place for weight than for height, both among boys and girls. Now School No. 5 contains 25 per cent. of Jewish children. It may be that Jewish children are heavier in proportion to their height than the average London child, but further evidence of this is desirable before asserting it. School No. 3, on the other hand, takes a higher place for height than for weight, but the notes on the school do not suffice to explain this result.

We cannot go any further with the present material, but it must be pointed out that the "School Heights" so found take no account of racial differences, and the necessity of allowing for the effects of race has already been insisted on in the introduction to this paper. To do so we require some indication of the nationality of the parents. In practice this is not easy. Failing a definite statement of nationality, we may reach some approximation to the racial constitution of the population by an examination of the children's surnames, especially in towns with large foreign elements. It must be remembered, of course, that the mother's surname disappears, and that many foreigners adopt English names, so that the number of foreigners would probably be considerably underestimated by this method. The better method, however, is to consider hair colour and eye colour as indicating the racial elements of the population.* Whichever method be adopted a simple extension of the process just given will enable us to find a "School Height" or "School Weight" independent of age distribution and of racial mixture, just as the Registrar-General's method can be extended to correct for differences of sex constitution as well as of age distribution. The use of a single coefficient to represent the stature or weight of a school is even more necessary here, because the only other way available for comparing two schools in respect of stature is to

* It will probably be necessary to classify by both hair and eye colours, either alone being found insufficient to determine the racial constitution of a district.

compare the average height of each race represented, or of each hair colour group, at each year of age, so that from thirty to forty averages would be necessary to represent adequately the stature of a single school. If we divide the children at each age directly into nationalities, or indirectly by classifying hair colour, and define ${}_am_5$ as the number of children of age 5 and nationality or hair colour "a", then the standard age distribution will still be $M=m_5+m_6+m_7\ldots$ where $m_5={}_am_5+{}_bm_5+\ldots$, and similarly, if ${}_ah_5$ be the average height of children aged 5, and of nationality or hair colour "a", then the number which represents the average height of the school, corrected for differences in age and racial distribution, will be

$$S.H.=\frac{h_5\,m_5+h_6\,m_6+\&c.}{M}=\frac{\Sigma hm}{M}$$

where $h_5\,m_5={}_ah_5\times{}_am_5+{}_bh_5\times{}_bm_5+{}_ch_5\times{}_cm_5+\&c.$ In the same way we can obtain a "School Weight" which will be independent of age and racial distribution. Only when this has been done shall we be in a position to compare the stature and weight of children of different schools or areas, or to test whether there is any relationship between stature, independent of age and race, and any environmental factors, such as the amount of pauperism in a district, the density of population, and other measures of social condition, just as has been done with the birth-rate in the Metropolitan Boroughs of London by the present writer *; only when those corrections have been made can we test whether the differences found between schools and districts are due to underfeeding and the like.

These coefficients for height and weight might usefully have been employed in the valuable Report on the Physical Condition of Glasgow School Children, by Dr. W. Leslie Mackenzie and Captain A. Foster,† who have analysed records of stature and weight of 72,857 children, and discussed the relation of stature and weight to the housing of the children. The result reached is that boys who live in one-roomed houses are 11·7 lb. lighter and 4·7 inches smaller than boys who live in four-roomed houses, while girls from one-roomed houses are 14 lb. lighter and 5·3 inches shorter than the girls from four-roomed houses. These figures are based on the average height and weight of children of all ages, and no correction is made for differences of age distribution.

I have calculated, from these Scottish statistics, the average height and weight, independent of age distribution, i.e. the "Class Height" and "Class Weight", for children in houses with one, two, three, and four rooms. These and the averages given in the Report are given in Table XXI.

* On the Relation of Fertility in Man to Social Status, and on the changes in this Relation that have taken place in the last fifty years. Drapers' Company Research Memoirs. Studies in National Deterioration I. Dulau & Co.

† Scotch Education Department, Cd. 3637. 1907.

TABLE XXI.

THE CHANGES MADE BY CORRECTING FOR DIFFERENCES IN AGE DISTRIBUTION ON AVERAGES OF HEIGHTS AND WEIGHTS OF GLASGOW CHILDREN.

Number of Rooms in House.	Averages before Correction.*				Averages after Correction.			
	Height (inches).		Weight (lbs.).		Height (inches).		Weight (lbs.).	
	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
One.	46·6	46·3	52·6	51·5	47·6	47·6	54·9	54·4
Two.	48·1	47·8	56·1	54·8	48·4	48·2	56·9	56·0
Three.	50·0	49·6	60·6	59·4	49·4	49·1	59·0	57·8
Four.	51·3	51·6	64·3	65·5	50·0	49·8	60·4	59·8
Range.	4·7	5·3	11·7	14·0	2·4	2·2	5·5	5·4

It will be seen from this table that the range is now *less than half* what it was before correction. Instead of boys from one-roomed houses being 11·7 lb. lighter and 4·7 inches smaller than boys from four-roomed houses, these differences are now only 5·5 lb. and 2·4 inches; instead of differences among the girls of 14 lb. and 5·3 inches we get differences of 5·4 lb. and 2·2 inches. The explanation of the marked change in these results is that among one-roomed boys only 2·4 per cent. are aged 14 and upwards, while among four-roomed boys the percentage is 11·9; among one-roomed girls only 2·3 per cent. are aged 14 and upwards, while among four-roomed girls the percentage rises to 14·8. As the number of children in a family increase they require of course more accommodation, even though there be no improvement in their circumstances. The housing conditions of children cannot be estimated accurately from a knowledge of the number of rooms alone; we require also the number of persons who occupy those rooms, so as to obtain the number of persons per room, which gives a far better idea of the home conditions of the children.

Can we say, then, that even these smaller differences are certainly due to bad home conditions? By no means. Mr. Tocher † has shown how widely divergent are the different districts of Glasgow in regard to hair and eye colour, and until we have allowed for these racial differences we cannot definitely assert that bad home conditions have any influence on the stature and weight of the children.

The correlation coefficients which indicate the relationship between age and height and between age and weight are given in Table XXII. There are obviously significant differences between the schools, but in the most divergent case this is due to an arbitrary age selection of the children, Standards I and II not being available. The regression coefficients, on the other hand, are practically equal, i. e. the slope of the regression lines are nearly the same in the different schools.

* Extracted from Mackenzie and Foster's Report, p. 56, Table 61.

† *Biometrika*, vol. vi, p. 129.

TABLE XXII.

THE RELATIONSHIP BETWEEN AGE AND HEIGHT AND BETWEEN AGE AND WEIGHT.

School Number.	Correlation Coefficients.			
	Boys.		Girls.	
	Age and Height.	Age and Weight.	Age and Height.	Age and Weight.
1	+·79±·01	+·78±·01	+·81±·01	+·75±·02
2	+·80±·02	+·76±·02	+·70±·02	+·73±·02
3	+·86±·01	+·78±·01	+·86±·01	+·81±·01
4	*(+·64±·02)	(+·60±·02)	+·82±·01	+·79±·01
5	+·80±·01	+·76±·01	+·81±·01	+·77±·01
6	+·86±·01	+·84±·01	+·87±·01	+·82±·01
7	+·83±·01	+·83±·01	+·88±·01	+·81±·01
8	+·83±·01	+·81±·01	+·88±·01	+·80±·01
9	+·82±·01	+·76±·01	+·83±·01	+·79±·02
10	+·85±·01	+·83±·01	+·80±·02	+·77±·02
11	+·88±·01	+·79±·01	+·84±·01	+·75±·01
12	—	—	+·83±·01	+·79±·01
13	—	—	+·78±·02	+·72±·02
14	+·84±·01	+·81±·01	—	—
Mean	+·83	+·80	+·82	+·77

when we compare age and height among boys or among girls, or age and weight among boys or among girls.

Similarly in Table XXIII are given the correlation coefficients indicating the relationship between height and weight. The maximum difference between two

TABLE XXIII.

THE RELATIONSHIP BETWEEN HEIGHT AND WEIGHT.

School Number.	Correlation Coefficients.	
	Boys.	Girls.
1	+·94	+·87
2	+·92	+·89
3	+·93	+·92
4	+·88	+·89
5	+·90	+·93
6	+·94	+·90
7	+·92	+·93
8	+·89	+·95
9	+·92	+·91
10	+·95	+·94
11	+·93	+ 92
12	—	+·91
13	—	+·91
14	+·94	—
Mean	+·92	+·91

NOTE.—The numbers on which those correlation coefficients are based range from 168 to 545. The probable error is thus in every case of the order ·01.

* In this school Standards I and II are not available.

schools is eight times its probable error, and thus is certainly significant, but the regression lines are even more divergent, so that there seem to be significant differences between the schools in this respect; this is probably due to the influence of the selection of age already indicated.

(9) THE RELATIONSHIPS BETWEEN MENTAL CAPACITY AND HEIGHT AND WEIGHT.

In considering these relationships, we must of course allow for the influence of age on height and weight. This is done by means of partial correlation coefficients. If r_{MH}, r_{MA}, r_{HA}, be the direct correlation coefficients between mental capacity and height, mental capacity and age, and height and age, then the correlation between mental capacity and height for a constant age is given by

$$_{A}R_{MH} = \frac{r_{MH} - r_{MA}r_{HA}}{\sqrt{1-r_{MA}^2}\ \sqrt{1-r_{HA}^2}}$$

and a similar formula holds for the correlation between weight and mental capacity for a constant age. The values of r_{MA}, r_{HA}, r_{WA} have already been given in Tables XII and XXII, and in Table XXIV and XXV I have given r_{MH}, r_{WH}, $_{a}R_{MH}$, $_{A}R_{MW}$ for the individual schools. It will at once be noticed that to allow for the influence of age makes no significant difference on the *average* of the correlation coefficients, but that the effect is really that of a reducing factor on the separate correlations. We have, for instance, twenty-five correlation coefficients between mental capacity and height, with a range of from $-\cdot 24$ to $+\cdot 29$, and a standard deviation of $\cdot 17$, while the partial correlation coefficients have a range of from $-\cdot 03$ to $+\cdot 18$, and their standard deviation is only $\cdot 05$, less than a third of the former value. Exactly the same result is obtained from the correlations between mental capacity and weight. The range of the direct correlation coefficients is from $-\cdot 21$ to $+\cdot 28$, and the standard deviation is $\cdot 16$, while the range of the partial correlation coefficients is from $-\cdot 04$ to $+\cdot 13$, and the standard deviation is $\cdot 05$. The effect of allowing for the influence of age is thus to leave the *average* correlation practically unaltered while materially reducing the range and variability of the correlation coefficients. The mean values are in all cases positive, but are very small, and no marked stress can be laid upon these relationships. In other words, if the height and weight of the children be primarily a result of their home environment and not largely due to racial differences, this environmental influence does not substantially affect their mental capacity.

This result is confirmed by examination of the individual returns, which are very irregular. Thus in the School *B*. 5 and *G*. 5, the boys show one of the relatively high relationships between height and mental capacity, while the girls show no relationship; a similar difference between the sexes is found in School No. 9 when dealing with the relationship between weight and mental capacity. It may be presumed that the home environment is the same for both boys and girls, and yet if mental capacity be affected by the state of nutrition,

TABLE XXIV.

The Relationship between Height and Mental Capacity.

School Number.	Boys.		Girls.	
	Correlation Ratios. Height and Mental Capacity:	Partial Correlation Coefficients. Height and Mental Capacity for a constant Age.	Correlation Ratios. Height and Mental Capacity.	Partial Correlation Coefficients. Height and Mental Capacity for a constant Age.
1	+·06±·04	+·06±·04	+·25±·04	+·08±·04
2	+·19±·04	+·04±·04	+·16±·05	+·11±·05
3	+·14±·03	+·15±·03	+·28±·04	+·12±·04
4	+·25±·04	+·13±·04	−·14±·03	+·01±·03
5	+·26±·04	+·08±·04	−·24±·03	−·03±·03
6	−·14±·03	+·07±·03	+·21±·04	+·08±·04
7	+·20±·03	+·18±·03	−·16±·03	+·16±·03
8	+·12±·04	+·08±·04	+·20±·04	+·11±·04
9	+·21±·04	+·15±·04	+·18±·04	+·07±·04
10	+·15±·04	+·11±·04	+·29±·05	+·11±·05
11	−·21±·03	+·02±·03	−·12±·03	−·02±·03
12	—	—	−·11±·03	+·03±·03
13	—	—	+·16±·04	+·08±·04
14	−·07±·04	+·11±·04	—	—
Mean	+·10	+·10	+·07	+·07

TABLE XXV.

The Relationship between Weight and Mental Capacity.

School Number.	Boys.		Girls.	
	Correlation Ratios. Weight and Mental Capacity.	Partial Correlation Coefficients. Weight and Mental Capacity for a constant Age.	Correlation Ratios. Weight and Mental Capacity.	Partial Correlation Coefficients. Weight and Mental Capacity for a constant Age.
1	+·06±·04	+·06±·04	+·27±·04	+·13±·04
2	+·21±·04	+·09±·04	+·15±·05	+·09±·05
3	+·13±·03	+·12±·03	+·28±·04	+·12±·04
4	+·14±·04	−·00±·04	−·14±·03	−·00±·03
5	+·20±·04	−·01±·04	−·20+·03	+·01±·03
6	−·15±·03	+·03±·03	+·21±·04	+·10±·04
7	+·18±·03	+·13±·03	−·18±·03	+·07±·03
8	+·10±·04	+·05±·04	+·18±·04	+·07±·04
9	+·18±·04	+·10±·04	+·12±·04	−·01±·04
10	+·11±·04	+·04±·04	+·19±·05	−·04±·05
11	−·21±·03	+·05±·03	−·10±·03	−·01±·03
12	—	—	−·11±·03	+·03±·03
13	—	—	+·08±·04	−·03±·04
14	−·11±·04	+·03±·04	—	—
Mean	+·07	+·06	+·05	+·03

and this by home conditions, the effect is quite different for boys and girls. If it be suggested that the bigger girls reach puberty sooner and that their mental energies may be thus lessened, some solution must be offered to the difficulty that these relationships rise to their highest positive values in *G*. 1 and *G*. 3 for weight, and in *G*. 3 and *G*. 7 for height. Further, not more than some eight of the fifty partial correlation coefficients can be considered significant, having regard to their probable errors. In other words, unless we are to consider the mental capacity scale as wholly valueless *relatively* as well as absolutely, i. e. unless we are to assume that no reliance is to be placed on the teachers' classification into intelligence groups in the individual schools, there is really no basis for the belief that mental capacity is substantially associated with the height and weight of the children.

(10) The Relationship between Mental Capacity and Qualitative Characters.

Having discussed the relationship between mental capacity and those characters which can be expressed on a quantitative scale, we must now deal with purely qualitative characters, such as the condition of the teeth and of the clothing, the state of nutrition, cleanliness, &c.

Two methods only are available for determining the relationship between mental capacity and any one of those characters, by forming a contingency table or a fourfold table. The contingency table was used in all cases where at least a twelvefold division, i.e. a three × fourfold division of the material could be made, and where this could not be done the fourfold table was used.

But before discussing in detail those relationships it will perhaps be profitable to look at the question in quite another way. Let us assume again that the distribution of mental capacity obeys the Gaussian law, and let us find for each grade of intelligence the centroid vertical and plot up on those verticals the percentages of children who possess in a given degree a certain character. To take an example, we find that in *B*. 7, of those children who are classed as brilliant 90 per cent. obtain marks IV or V for the condition of the clothing, i. e. in those cases the condition of the clothing is at least above the average. Of the children who are above "the average" in intelligence 91 per cent. reach the standard "above the average" for the condition of the clothing; while in the "average", "under the average", and "very dull and backward" groups of intelligence, the percentages are 84, 72, and 44 respectively. It is clear then that, *so far as this school is concerned*, there is some relationship between mental capacity and the condition of the clothing, and, further, that this relationship is *positive*, i. e. the higher the intelligence the better the condition of the clothing. If these numbers are expressed graphically we obtain a diagram which Professor Pearson has termed an *analograph*.*

* See *Biometrika*, vol. v, p. 129.

If the percentages increase or decrease uniformly with mental capacity, a more or less close relationship between mental capacity and the character under consideration is indicated. In such cases the analograph is said to be "homoclinal", while if the percentage does not reach its maximum with the maximum or minimum of intelligence it is said to be "heteroclinal".

The analograph is also useful in another way; as has already been pointed out, the contingency coefficient has essentially no sign, but if we are to consider the correlation between two characters to be determined by a contingency coefficient we must prefix a positive or negative sign to the arithmetical value found from the contingency table, and this sign can usually be determined from the analograph. The procedure to be adopted in doubtful cases has already been discussed.

Analographs have been constructed to show the relationship between mental capacity and seven other characters for the boys' and girls' departments of School No. 7, and these are given in Fig. 12.

It should be noted that the deductions drawn from these analographs apply only to those two schools, and in general cannot be extended to the other schools where the analographs may show actually reversed conditions.

In the boys' department, five groups of mental capacity are used, but in the girls' department there are only six girls who are classed as "brilliant", so that here the two groups "above the average" and "brilliant" have been combined, another illustration of the difficulties of the investigation.

To take individual cases there is clearly, as has been stated, some relationship between intelligence and the condition of the clothing, and this is seen to be true both for the boys and the girls of this School, No. 7.

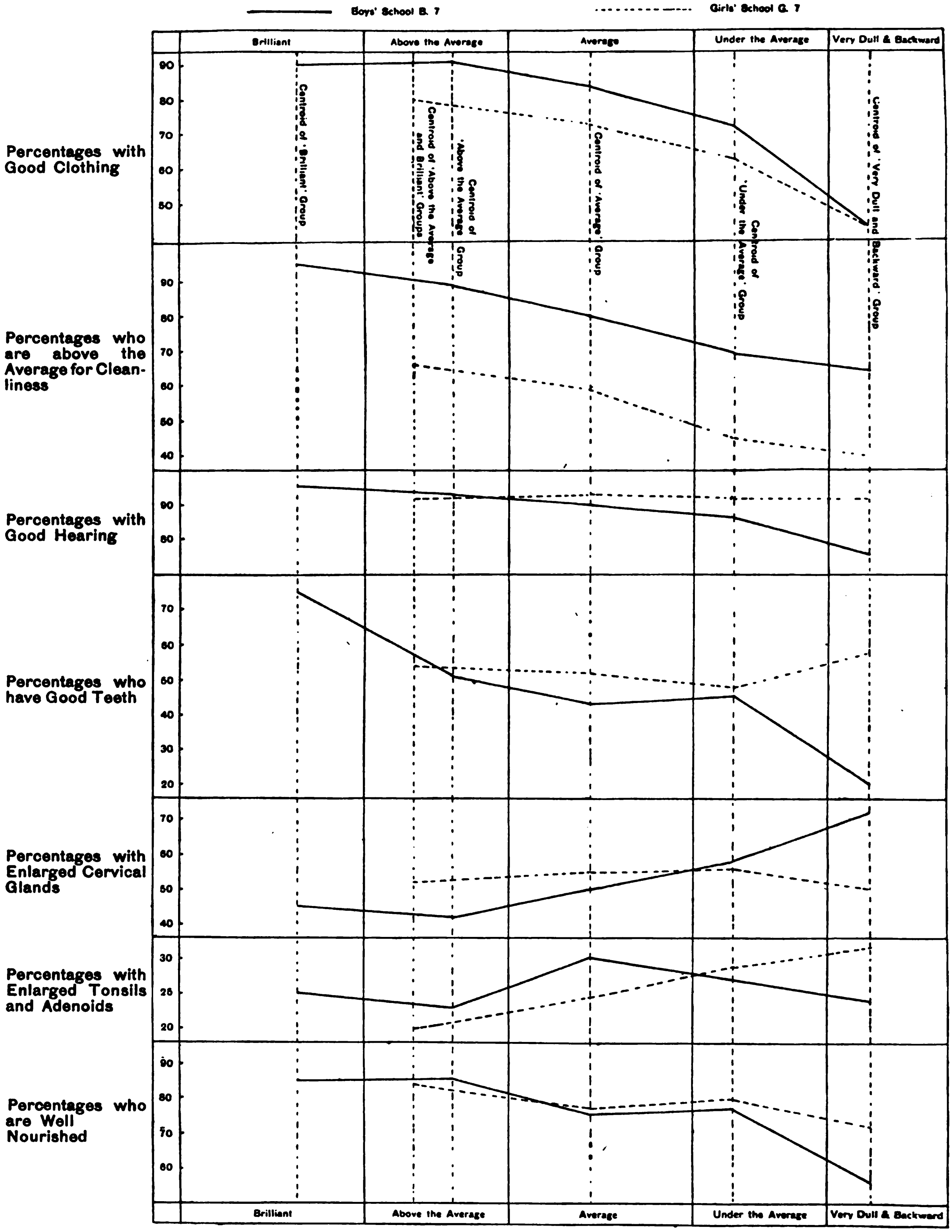
Similarly, I have plotted on the centroid verticals of the mental capacity groups, the percentage of children who obtain the marks IV or V for their state of cleanliness. Here, again, the relationship is homoclinal and the percentage decreases as we pass from the "brilliant" to the "dull".

The percentage of boys who have normal hearing decreases slightly with decreasing intelligence; among the girls there is no sensible difference between the groups.

The relationship between the condition of the teeth and mental capacity is more marked among the boys than among the girls; similarly the percentages of boys whose glands are enlarged increase from 45 to 72 as we pass from the "brilliant" group to the "dull", i.e. with increased intelligence the condition of the glands improves; among the girls, on the other hand, the differences are hardly significant and the relationship is heteroclinal.

The condition of the tonsils and adenoids, again, is slightly correlated with mental capacity in the case of the girls, and not at all in the case of the boys.

FIG. 12. ANALOGRAPHS OF VARIOUS CHARACTERS FOR EACH GRADE OF MENTAL CAPACITY.



Unfortunately there is no uniformity among the different schools, and we find that the percentages sometimes increase and sometimes decrease with intelligence, just as we have found correlation coefficients to be sometimes positive among the boys and negative among the girls of the same school.

(11) The Relationship between Mental Capacity and the Condition of the Teeth.

We can now investigate the relationships between mental capacity and the physical conditions of the children for individual schools.

In every school there is given an estimate of the children's teeth. Unfortunately the system of classification adopted varies very considerably from one school to another. In each case the marks I, II, III, IV, V, are used, but in different schools they represent very different conditions. Thus in the Schools *B.* 2 and *G.* 2 and *G.* 12 the scale used was:

I. Several (more than four) carious teeth.
II. Two to four carious teeth.
III. Average, not more than two slightly carious.
IV. One or more carious.
V. Perfect set, clean, and no caries.

It is not clear what is the distinction between groups 3 and 4, and this makes the scale somewhat unsatisfactory.

In *B.* 3 and *G.* 3, *B.* 6 and *G.* 6, the scale adopted is very vague:

I. Very bad.
II. Fairly bad.
III. Medium.
IV. Good.
V. Very good.

This is practically the general scale of marks given in the introduction, and seems to have been adopted in most of the schools.

In *B.* 5 and *G.* 5 the scale used was much better, and might well be adopted as a standard scale:

I. Practically edentulous; no teeth capable of performing useful mastication.
II. Capable of masticating food but no sound teeth.
III. Good serviceable set with two or three decayed or lost.
IV. One tooth only decayed or lost.
V. A perfect set of teeth.

Now it is clear that the mark I in *B.* 2, *G.* 2, and *G.* 12, given to children who have more than four carious teeth stands for a condition very different from that to which the mark I is given in *B.* 5 and *G.* 5—to children who have no teeth capable of performing useful mastication, and we have no means of comparing

either classification with a vague term such as "very bad". Accordingly, a comparison between the numbers who are placed in the various classes in the different schools loses much of its value, and we cannot estimate the general condition of the teeth in the different schools, but can only compare the boys' and girls' departments of the same schools.

The percentages in each grade in each school are given in Table XXVI, but we can only say that on the whole the condition of the teeth is nearly the same among the boys and girls of the same school; the only exception is in *B.* 1 and *G.* 1, where the boys seem to have worse teeth than the girls. We see that the percentage of children who get the highest mark for the condition of their teeth varies from 0 to 31, but we cannot tell how much is real and how much is due to the use of different scales.

TABLE XXVI.

THE VARIATION IN THE CONDITION OF THE TEETH IN THE INDIVIDUAL SCHOOLS.

School Number.	Boys. Condition of Teeth. Percentages in Each Grade.					Girls. Condition of Teeth. Percentages in Each Grade.				
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
1	—	7	62	24	7	1	15	46	24	15
2	1	15	57	26	1	—	23	57	19	—
3	—	29	61	9	1	2	41	48	9	—
4	—	7	53	26	15	—	16	46	19	19
5	—	21	50	22	7	1	13	58	21	7
6	3	37	46	13	2	1	36	56	6	1
7	1	20	35	21	24	1	14	34	22	30
8	—	13	54	19	14	—	8	55	21	16
9	—	17	45	28	10	—	8	52	27	13
10	—	10	28	31	31	—	4	27	38	31
11	—	27	20	25	28	—	20	21	28	31
12	—	—	—	—	—	12	30	42	16	—
13	—	—	—	—	—	—	17	52	20	12
14	3	14	54	19	10	—	—	—	—	—

That the teeth of children are extraordinarily susceptible to treatment is clearly indicated by an interesting example of the immense improvement in the condition of the teeth that can be effected by dental care given in Dr. Kerr's Report for 1906.*

Among the pupils attending Dulwich Schools are a number of children from Lambeth Workhouse. Each of those children is inspected twice yearly by a dentist and the result is that 70 per cent. of those workhouse children are free from obvious

* Report of the Education Committee of the London County Council, submitting the Report of the Medical Officer (Education) for the year ending March 31, 1906, pp. 16 et seq.

dental disease, while among the other Dulwich school children only 30 per cent. are free from obvious dental disease. It is probable, too, that the more reasonable diet of the workhouse children was not without its own influence.

The contingency coefficients indicating the relationship between mental capacity and the condition of the teeth are given in Table XXVII.

TABLE XXVII.

The Relationship between the Condition of the Teeth and Mental Capacity.

School Number.	Boys. Direct Correlation between Mental Capacity and the Condition of the Teeth.	Boys. Correlation between Mental Capacity and the Condition of the Teeth for a constant Age.	Girls. Direct Correlation between Mental Capacity and the Condition of the Teeth.	Girls. Correlation between Mental Capacity and the Condition of the Teeth for a constant Age.
1	+ ·17 ± ·04	+ ·17 ± ·04	+ ·14 ± ·04	+ ·18 ± ·04
2	+ ·13 ± ·04	+ ·08 ± ·04	+ ·15 ± ·05	+ ·12 ± ·05
3	+ ·13 ± ·03	+ ·12 ± ·03	+ ·22 ± ·04	+ ·18 ± ·04
4	+ ·16 ± ·04	+ ·12 ± ·04	+ ·14 ± ·03	+ ·18 ± ·03
5	+ ·16 ± ·04	+ ·13 ± ·04	− ·13 ± ·03	− ·07 ± ·03
6	+ ·09 ± ·03	+ ·12 ± ·03	+ ·14 ± ·04	+ ·11 ± ·04
7	+ ·17 ± ·03	+ ·16 ± ·03	+ ·11 ± ·03	+ ·17 ± ·03
8	− ·12 ± ·04	− ·14 ± ·04	+ ·18 ± ·04	+ ·15 ± ·04
9	− ·17 ± ·04	− ·21 ± ·04	+ ·12 ± ·04	+ ·09 ± ·04
10	+ ·26 ± ·04	+ ·24 ± ·04	+ ·23 ± ·05	+ ·17 ± ·05
11	− ·10 ± ·03	− ·05 ± ·03	− ·20 ± ·03	− ·19 ± ·03
12	—	—	+ ·15 ± ·03	+ ·20 ± ·03
13	—	—	− ·13 ± ·04	− ·17 ± ·04
14	+ ·19 ± ·04	+ ·16 ± ·04	—	—
Mean	+ ·08	+ ·08	+ ·08	+ ·09

There is again a large variation in those coefficients, and although the average of both boys' and girls' schools is positive, in both cases it is small and does not indicate any marked relationship between mental capacity and the condition of the teeth.

The possibility of the condition of the teeth being highly correlated with the age of the child makes it necessary that we should correct for age by means of a partial correlation coefficient, just as in the cases of height and weight. Here the correlation between intelligence and the condition of the teeth for a constant age

$$ {}_A R_{TM} = \frac{r_{TM} - r_{TA} r_{MA}}{\sqrt{1 - r_{TA}^2}\,\sqrt{1 - r_{MA}^2}} $$

The values of r_{MA}, the relationship between mental capacity and age have already been given, and those of r_{TA} will be given later, when we consider the influence of age on various physical conditions. Both r_{TA} and r_{MA} are small, so that we find that the correction for age makes very little difference in the result. The partial

correlation coefficients for every school are also given in Table XXVII, and the differences between the corrected and uncorrected values are very small. We must conclude then that the condition of the teeth is not associated in any marked degree with intelligence.

(12) The Relationship between Mental Capacity and the Condition of the Clothing.

In seven boys' schools and six girls' schools there is given an estimate of the condition of the children's clothing. In the original memorandum which outlined the scheme of inspection a very definite classification of the condition of the clothing was given:

I. The clothing of the scantiest possible, e.g. one ragged coat, buttoned up, and practically nothing found beneath it; boots either absent or represented by a mass of rags tied upon the feet.

II. Clothing insufficient to retain animal heat and needing urgent remedy, boots leaking.

III. Clothing poor, but passable; an old and perhaps ragged suit, with some attempt at proper underclothing, usually of flannelette.

IV. Well clad, stuff suit, good boots, and a flannel undergarment or a jersey; poor but sufficient.

V. Very well clad.

This is a very definite scale and might be expected to give good results, but when we look at the percentages of children in each of these classes for each school, as given in Table XXVIII, we see that again we have extraordinary variation in

TABLE XXVIII.

The Variation in the Condition of the Clothing in the Individual Schools.

School Number.	Boys. Condition of Clothing. Percentage in each Grade.					Girls. Condition of Clothing. Percentage in each Grade.				
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
1	1	20	49	27	2	—	5	24	36	35
2	—	19	41	40	1	—	—	—	—	—
4	—	18	26	39	18	—	3	12	37	48
7	—	4	13	32	50	—	1	10	20	68
10	—	3	7	36	54	—	2	15	45	38
11	—	3	11	26	61	—	—	5	11	84
13	—	—	—	—	—	1	22	11	17	48
14	6	29	53	12	—	—	—	—	—	—

the percentages. Now it is only to be expected that the condition of the clothing will vary considerably from one school to another, but surely this cannot be the case when we compare the boys' and girls' departments of the same school. Take, for instance, School No. 1. Of the boys only 2 per cent. obtain the highest mark, while 35 per cent. of the girls obtain this mark. In no school is the condition of the clothing even approximately the same for boys as for girls.

Now the condition of the clothing is one of the characteristics by which several authorities have hoped to measure the home environment, and yet this table seems to show that sex produces fundamental differences.

The same sexual differences are seen when we consider the relationships between mental capacity and the condition of the clothing. The results are given in Table XXIX. Thus in School No. 10, the better clothed boy is on the average

TABLE XXIX.

THE RELATIONSHIP BETWEEN THE CONDITION OF THE CLOTHING AND MENTAL CAPACITY.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
1	Contingency	$+\cdot17\pm\cdot04$	Contingency.	$+\cdot23\pm\cdot04$
2	,,	$-\cdot23\pm\cdot04$		
4	,,	$+\cdot14\pm\cdot04$	,,	$+\cdot30\pm\cdot03$
7	,,	$+\cdot35\pm\cdot03$	,,	$+\cdot26\pm\cdot03$
10	,,	$-\cdot19\pm\cdot04$	,,	$+\cdot21\pm\cdot05$
11	Fourfold Table	$+\cdot03\pm\cdot03$	Fourfold Table	$+\cdot22\pm\cdot03$
13			Contingency	$+\cdot20\pm\cdot04$
14	Contingency	$+\cdot03\pm\cdot04$		
Mean		$+\cdot04$		$+\cdot24$

less intelligent, while the better clothed girl is on the average *more* intelligent and to the same degree. It is possible that in measuring mental capacity in the girls, neatness of dress has been invariably included as a factor, while with the boys this depends on the individual teacher. It seems impossible therefore to use the condition of the clothing as an effective test of home environment so long as the source of these inconsistencies is undetermined. It seems more reasonable to suppose that mental capacity (either directly or because the abler child is the child of abler parents) produces neater clothes and that this is far more the rule with girls than with boys. It would be difficult even with the steady values obtained for girls to assert that good clothing was a sign of good home environment and that that was associated with intelligence. The orderly-minded parents may produce an orderly-minded child as well as provide orderly attire for their children, and the fact that even intelligent and mentally active boys will "tear their clothes to pieces" may explain this sex difference and show how little service a school

appreciation of clothing may sometimes be as a measure of home environment. The actual survey of the homes is the only way to reach the truth on this question of the use of the condition of the clothing as a measure of home environment, and the influence of the latter, apart from heredity, on mental capacity.

(13) The Relationship between Mental Capacity and the State of Nutrition.

The estimation of the state of nutrition of a child presents peculiar difficulties. There seems to be no certain method by which the underfed child may be distinguished, and no satisfactory scale of nutrition has yet been evolved.

In the present investigation no fewer than *five* different scales were used, and even the best is somewhat indefinite, and probably no two medical men would classify under it in exactly the same way. The scale which seems most satisfactory is that used in *B.* 5 and *G.* 5 :

I. Very poor muscular development with little or no subcutaneous fat.

II. Either very poor muscular development with fair amount of fat, or vice versa.

III. Fair all round development.

IV. Very good muscular development with only fair general nutrition, or vice versa.

V. The "pink of condition".

This scale is fairly definite and ought to give satisfactory results, but three other scales are used which are exceedingly vague. The second scale given is used in Schools Nos. 2 and 12, the third in Schools Nos. 3 and 6, and the fourth in Schools Nos. 8 and 9.

Mark.	2nd Scale.	3rd Scale.	4th Scale.
I	Very thin.	Very bad.	Emaciated.
II	Thin.	Fairly bad.	Badly nourished.
III	Average.	Medium.	Fairly well nourished.
IV	Well nourished.	Good.	Well nourished.
V	Stout.	Very good.	Excellently well nourished.

In Schools Nos. 7 and 11, a fifth scale is used in which only the marks I, II, III are used, thus rendering impossible any comparison between these and the rest of the schools. The scale is :

I. A child of very inferior physique.

II. A child below the normal.

III. A well-nourished child.

Of course any one of these scales would probably work quite satisfactorily in the hands of the medical man who drew it up, but what is required is some scale which leaves little or no room for individual idiosyncrasies, that is, it must approxi-

mate as closely as possible to the quantitative, but the problem is no doubt a very difficult one.

The percentage of children who are placed in the different grades are given in Table XXX. There seems to be on the whole rather better agreement between the boys and girls of the same school.

TABLE XXX.

THE VARIATION IN THE STATE OF NUTRITION IN THE INDIVIDUAL SCHOOLS.

School Number.	Boys. State of Nutrition. Percentage in each Grade. I.	II.	III.	IV.	V.	Girls. State of Nutrition. Percentage in each Grade. I.	II.	III.	IV.	V.
2	—	5	64	30	—	1	12	54	31	1
3	—	4	75	19	1	—	12	56	29	3
5	—	11	51	31	8	1	13	60	20	4
6	—	13	67	17	2	—	16	63	20	2
7	2	24	74	—	—	—	21	79	—	—
8	—	1	61	33	5	—	1	48	43	8
9	—	3	57	36	4	—	3	55	33	9
11	—	9	91	—	—	—	14	85	—	—
12	—	—	—	—	—	1	14	61	21	2

If all the schools had been examined in the same way, using the same uniform scale, the question of how to classify the schools, in respect of the state of nutrition of the children, would have arisen. It is useful in such cases to obtain a single number which will sum up all the observations relating to a single school or area just as we have done in the cases of height and weight.

Nutrition, of course, must be expressed on a qualitative scale, but by assuming, as in the case of mental capacity, that the distribution of nutrition follows the normal curve of error, we can reduce this qualitative scale to a quantitative one, and so obtain an Index of Nutrition by which all the schools in a district can be compared *inter se.* The method can, of course, be applied to any character which is expressed on a qualitative scale. If the children of all the schools under consideration taken together are arranged in five groups in respect of nutrition, and the numbers in each group are $n_1+n_2+n_3+n_4+n_5=N$, then, on the assumption that the distribution of nutrition is normal, we can find the distances of the centroid verticals of each group from the mean of the whole. Let these distances be h_1, h_2, h_3, &c., then $\Sigma nh=0$. If now $m_1+m_2+m_3+m_4+m_5=M$ be the distribution of nutrition in any individual school, $\frac{\Sigma mh}{M}$ will measure the state of nutrition in that school relative to the whole of the schools considered. It will be convenient to take as our Index of Nutrition,

$$I.N.=100\ \frac{\Sigma mh}{M}$$

This coefficient will be positive when the state of nutrition in the school is above the average, zero when it is exactly the same as in the whole, and negative when below the average.

Such a scale will not, of course, allow for racial differences. We can do so on the basis of hair and eye colour, for instance, by finding this coefficient for each hair and eye colour group, but it is better in many ways to get a single coefficient to represent for a single school the general state of nutrition therein. A simple extension of the method just given will enable us to do so. As before, we require to base our Index on a standard distribution of hair and eye colour. Let the hair and eye colour groups necessary for classifying the children into racial groups be a, b, c . . ., let the state of Nutrition in a single school for hair and eye colour "a" be N_a as measured by the above method, and let the total number of children in all the schools be p_a, then the Index of Nutrition for the school under consideration, which will be independent of racial distribution, will be

$$I.N._H = \frac{N_a\, p_a + N_b\, p_b + N_c\, p_c + \&c.}{N}$$

and if a few hair and eye colour groups are sufficient, the extra labour is not prohibitive. We can thus obtain for a school or an area a single coefficient which will serve for comparison with the other schools or areas included in the observations, and which will be independent of racial distribution. It is assumed here that age has no effect on nutrition; if it has (see p. 57), the method must then be extended to allow for this.

This process has been carried out in the case of six boys' departments and seven girls' departments (all the schools in which the marks I, II, III, IV, V have been used), but the result must be regarded solely as an illustration of method, because no fewer than four different scales are used in those schools, and also because we have no means of estimating the racial elements in the schools. The results are given in Table XXXI.

TABLE XXXI.

INDEX OF NUTRITION FOR SEVEN SCHOOLS.

School Number.	Index of Nutrition.	
	Boys.	Girls.
2	+ ·3	− 9·2
3	−11·3	− 4·7
5	+11·0	−13·6
6	−23·8	−26·1
8	+22·8	+41·0
9	+17·9	+28·5
12	—	−23·4

It will be seen that, except No. 5, there is at least a fair agreement between the boys and girls of the same school. Schools Nos. 8 and 9 are clearly much above the average, and No. 6 below it. If, however, we compare these results with the "School Heights" and "School Weights" already given, we find in Table XXXII that while No. 6 gets the lowest place for nutrition it gets the highest place for height and weight. It is of course quite reasonable to suppose that the state of nutrition is quite independent of height and weight, but if so, school or class height and weight differences have not the significance which is sometimes attributed to them. Until all the schools are examined on the same basis we cannot go further.

TABLE XXXII.

Place Order for Height, Weight, and Nutrition for the Boys and Girls of Six Schools.

Place Order.	Nutrition.		Height.		Weight.	
	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
1	No. 8	No. 8	No. 6	No. 3	No. 6	No. 6
2	„ 9	„ 9	„ 3	„ 6	„ 5	„ 5
3	„ 5	„ 3	„ 8	„ 8	„ 3	„ 8
4	„ 2	„ 2	„ 5	„ 9	„ 8	„ 3
5	„ 3	„ 5	„ 9	„ 2	„ 9	„ 9
6	„ 6	„ 6	„ 2	„ 5	„ 2	„ 2

The degree of relationship between mental capacity and the state of nutrition is indicated in Table XXXIII, where the various contingency and correlation coefficients are given. We have here, as before, positive and negative coefficients; the average, however, among both boys and girls is very small, and we must conclude that there is no relationship between mental capacity and the state of nutrition, but that the roughness of the material and the difficulties of classification combine to make some of the coefficients sensible as compared with their probable errors.

TABLE XXXIII.

The Relationship between the State of Nutrition and Mental Capacity.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
2	Contingency	$-\cdot 16 \pm \cdot 04$	Contingency	$+\cdot 22 \pm \cdot 05$
3	„	$+\cdot 13 \pm \cdot 03$	„	$+\cdot 23 \pm \cdot 04$
5	„	$-\cdot 19 \pm \cdot 04$	„	$-\cdot 12 \pm \cdot 03$
6	„	$+\cdot 10 \pm \cdot 03$	„	$+\cdot 11 \pm \cdot 04$
7	Fourfold Table	$+\cdot 12 \pm \cdot 03$	Fourfold Table	$+\cdot 03 \pm \cdot 03$
8	Contingency	$-\cdot 12 \pm \cdot 04$	Contingency	$+\cdot 15 \pm \cdot 04$
9	„	$+\cdot 15 \pm \cdot 04$	„	$+\cdot 20 \pm \cdot 04$
11	Fourfold Table	$+\cdot 03 \pm \cdot 03$	Fourfold Table	$+\cdot 16 \pm \cdot 03$
12		—	Contingency	$-\cdot 14 \pm \cdot 03$
Mean		$+\cdot 01$		$+\cdot 08$

(14) The Relationship between Mental Capacity and the State of Cleanliness.

In the original memorandum the scale proposed to be used in estimating the state of cleanliness of the children is as follows:

I. Very dirty and verminous. II. Clothes and body dirty, but not verminous. III. Passably clean for boys (or girls). IV. Clean (above the average) for boys (or girls). V. Unexceptionable.

The percentages of children who are placed in each of these groups are, however, very irregular, as shown in Table XXXIV. Thus, in *G.* 7 and *G.* 11 groups II and V are very large, while groups III and IV are very small. In *G.* 11, for instance, 38 per cent. of the girls are placed in group II, none in group III, only 8 per cent. in group IV, and 52 per cent. in group V. Similarly, in *B.* 4, 17 per cent. get the mark V, while in *G.* 4, the girls' department of the same school, 47 per cent. of the girls get this mark. So also in School No. 1, only 1 per cent. of the boys get the mark V, while 33 per cent. of the girls get this mark. It is not easy to understand how such distributions could arise, nor to explain such differences between the boys and girls of the same schools, and this furnishes an excellent example of the difficulties of dealing with the material.* All we can do is to treat each school separately and take the average of the results.

TABLE XXXIV.

The Variation in the State of Cleanliness in the Individual Schools.

School Number.	Boys.					Girls.				
	State of Cleanliness.					State of Cleanliness.				
	Percentage in each Grade.					Percentage in each Grade.				
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
1	5	22	50	22	1	2	18	28	19	33
4	3	7	28	45	17	—	14	22	16	47
7	1	11	8	38	42	2	41	4	15	38
10	—	3	10	23	64	1	1	4	18	77
11	—	4	5	47	43	1	38	—	8	52
13	—	—	—	—	—	2	12	21	17	48
14	8	31	50	11	—	—	—	—	—	—

The amount of relationship between mental capacity and the state of cleanliness is shown in Table XXXV. The average correlation is larger among the boys than among the girls, but the averages are small. Here, again, we meet the difficulty that boys and girls from the same school, and apparently from the same home environment, show quite contradictory results. Further, the results found

* Dr. Kerr, however, says that there are marked differences between boys and girls with regard to the character of their cleanliness. While the girls' clothing may be clean and tidy, the boys' is often torn and dirty. The girls' hair, on the other hand, is more frequently dirty and verminous.

when estimating home conditions by the state of cleanliness of the children are sometimes opposed to those found when we estimated (p. 46) home conditions by the condition of the clothing.

TABLE XXXV.

THE RELATIONSHIP BETWEEN THE STATE OF CLEANLINESS AND MENTAL CAPACITY.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
1	Contingency	$+\cdot 14\pm\cdot 04$	Contingency	$+\cdot 15\pm\cdot 04$
4	"	$+\cdot 19\pm\cdot 04$	"	$+\cdot 15\pm\cdot 03$
7	"	$+\cdot 26\pm\cdot 03$	"	$+\cdot 21\pm\cdot 03$
10	"	$+\cdot 18\pm\cdot 04$	Fourfold Table	$-\cdot 08\pm\cdot 05$
11	Fourfold Table	$+\cdot 16\pm\cdot 03$	" "	$+\cdot 06\pm\cdot 03$
13	—	—	Contingency	$-\cdot 10\pm\cdot 04$
14	Contingency	$-\cdot 12\pm\cdot 04$		—
Mean		$+\cdot 14$		$+\cdot 07$

(15) THE RELATIONSHIPS BETWEEN MENTAL CAPACITY AND THE CONDITION OF THE CERVICAL GLANDS, TONSILS AND ADENOIDS, AND POWER OF HEARING.

In the case of the boys' and girls' departments of three schools, we are given an estimate of the condition of the cervical glands, of the tonsils and adenoids, and of the power of hearing. These children seem to have been examined by the same medical man, and so more stress can be laid upon a comparison between the schools. Dealing first of all with the condition of the cervical glands, we find unfortunately that two different scales have been used. In schools Nos. 7 and 11, the scale used is:

I. The cervical glands cannot be felt.
II. The cervical glands can just be felt.
III. The cervical glands are enlarged to the size of hazel nuts.
IV. The cervical glands are enlarged to double the size of hazel nuts.
V. Abscess.

In the case of No. 10, on the other hand, the only marks used are 0 and +, 0 denoting that the glands are not enlarged, and + that they are. Probably classes II, III, IV, and V in the first scale taken together are nearly the same as + in the second, and from Table XXXVI we see that we have excellent agreement between the boys and girls of the same school, and that the schools do not differ widely from each other. A reference to the short notes on those schools on p. 8 shows, however, that they are very alike in general conditions, and that large differences are not to be expected.

TABLE XXXVI.

The Variation in the Condition of the Cervical Glands in the Individual Schools.

School Number.	Boys.					Girls.					
	Condition of Cervical Glands.					Condition of Cervical Glands.					
	Percentage in each Grade.					Percentage in each Grade.					
	0	+	I	II	III	0	+	I	II	III	IV
7	8	—	41	46	4	11	—	35	53	1	—
10	7	92	—	—	—	8	92	—	—	—	—
11	15	—	57	27	1	10	—	59	31	—	—

The contingency and correlation coefficients indicating the relationship between mental capacity and the condition of the cervical glands are given in Table XXXVII. They show in every case a small positive correlation, but the averages are small and afford no means of predicting any appreciable variation of intelligence from the condition of the glands.

TABLE XXXVII.

The Relationship between the Condition of the Cervical Glands and Mental Capacity.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
7′	Contingency	$+\cdot20\pm\cdot03$	Fourfold Table	$+\cdot08\pm\cdot03$
10	Fourfold Table	$+\cdot01\pm\cdot04$	,, ,,	$+\cdot06\pm\cdot05$
11	,, ,,	$+\cdot05\pm\cdot03$	,, ,,	$+\cdot09\pm\cdot03$
Mean		$+\cdot09$		$+\cdot08$

In estimating the condition of the tonsils and adenoids, two marks only were used, 0 and +. "0" was used to indicate that the tonsils were not enlarged nor adenoids present, and "+" to denote that they were. The proportions falling in each class in each school are given in Table XXXVIII, and show that while

TABLE XXXVIII.

The Variation in the Condition of the Tonsils and Adenoids in the Individual Schools.

School Number.	Boys.		Girls.	
	Condition of Tonsils and Adenoids.		Condition of Tonsils and Adenoids.	
	Percentage in each Grade.		Percentage in each Grade.	
	0	+	0	+
7	72	28	74	26
10	59	41	59	41
11	71	29	73	27

Schools Nos. 7 and 11 are substantially the same, the state of affairs in No. 10 is not quite so good, 41 per cent. of the children in this school having enlarged tonsils compared with from 26 per cent. to 29 per cent. in the other two schools. There are no differences between the sexes in any of the schools.

Since two groups only are used in estimating this condition, fourfold tables must be used to determine the relationship between mental capacity and the condition of the tonsils and adenoids, and the results are given in Table XXXIX. The correlation coefficients are small, though consistently positive, among the girls, but not large enough to enable us to say that any definite relationship does exist.

TABLE XXXIX.

THE RELATIONSHIP BETWEEN THE CONDITION OF THE TONSILS AND ADENOIDS AND MENTAL CAPACITY.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
7	Fourfold Table	$+\cdot03\pm\cdot03$	Fourfold Table	$+\cdot12\pm\cdot03$
10	" "	$-\cdot05\pm\cdot04$	" "	$+\cdot16\pm\cdot05$
11	" "	$-\cdot01\pm\cdot03$	" "	$+\cdot04\pm\cdot03$
Mean		$-\cdot01$		$+\cdot11$

In estimating the condition of the power of hearing the mark III has been given to the usual condition of that faculty, II to slightly impaired hearing, I to considerably impaired hearing, while 0 denotes a very bad condition. The marks IV and V were given to those who had a very acute sense of hearing, but the numbers who obtain those marks do not amount to 1 per cent. From Table XL it will be

TABLE XL.

THE VARIATION IN THE HEARING POWER IN THE INDIVIDUAL SCHOOLS.

School Number.	Boys. Percentage in each Grade.					Girls. Percentage in each Grade.					
	I.	II.	III.	IV.	V.	0.	I.	II.	III.	IV.	V.
7	—	10	89	—	—	—	1	7	92	—	—
10	—	14	85	—	—	1	1	11	88	—	—
11	—	4	96	—	—	—	—	4	95	—	—

seen that No. 11 is somewhat better than the others, but that the differences between the schools are small, and that there are no sexual differences. When we turn to the relationship between mental capacity and the power of hearing, as given in Table XLI, we find great diversity not only between different schools but between the boys and girls of the same school; thus in the case of School No. 11,

among the boys the correlation is $-\cdot13$, while among the girls it is $+\cdot28$. Little stress must be laid on those results because the division into fourfold form is very unsatisfactory, the displacement of one child into an adjoining compartment of the fourfold table would make a considerable difference to the value found for the correlation.

TABLE XLI.

The Relationship between the Hearing Power and Mental Capacity.

School Number.	Boys.		Girls.	
	Method.	Correlation.	Method.	Correlation.
7	Fourfold Table	$+\cdot23\pm\cdot03$	Fourfold Table	$+\cdot03\pm\cdot03$
10	,, ,,	$-\cdot01\pm\cdot04$	,, ,,	$+\cdot21\pm\cdot05$
11	,, ,,	$-\cdot13\pm\cdot03$	,, ,,	$+\cdot28\pm\cdot03$
Mean		$+\cdot03$		$+\cdot17$

(16) The Relationship between Age and Various Physical Characters.

I have already dealt with the influence of age on mental capacity, height, and weight, and the correlations between age and the condition of the teeth have been used to find the relationship between mental capacity and the condition of the teeth, independent of age. These correlations are now given in Table XLII.

TABLE XLII.

The Relationship between Age and the Condition of the Teeth.

School Number.	Boys.	Girls.
1	$+\cdot17\pm\cdot04$	$+\cdot12\pm\cdot04$
2	$+\cdot27\pm.04$	$+\cdot32\pm\cdot04$
3	$+\cdot27\pm\cdot03$	$+\cdot21\pm\cdot03$
4	$+\cdot17\pm\cdot04$	$+\cdot19\pm\cdot03$
5	$+\cdot13\pm\cdot03$	$+\cdot23\pm\cdot03$
6	$+\cdot15\pm\cdot03$	$+\cdot17\pm\cdot04$
7	$+\cdot12\pm\cdot03$	$+\cdot20\pm\cdot03$
8	$+\cdot19\pm\cdot03$	$+\cdot18\pm\cdot04$
9	$+\cdot22\pm\cdot04$	$+\cdot18\pm\cdot04$
10	$+\cdot20\pm.04$	$+\cdot25\pm\cdot05$
11	$+\cdot24\pm\cdot03$	$+\cdot14\pm\cdot03$
12	—	$+\cdot25\pm\cdot04$
13	—	$+\cdot32\pm\cdot03$
14	$-\cdot25\pm\cdot04$	—
Mean	$+\cdot16$	$+\cdot21$

They were calculated as correlation ratios. In every case but one the correlation is positive, and in the exceptional case, *B*. 14, it is e[illegible]ingly difficult to say whether the sign should be + or −, the regression line [illegible] very far from linear. It is clear, then, that there is a definite relationship bet[illegible]age and the condition

of the teeth, but the medical officers do not appear to have made any distinction between permanent and temporary teeth, so that a positive sign is to be expected. At higher ages the teeth would of course deteriorate, and the sign to be given to this relationship when older children are included would probably be a negative one.

In Table XLIII I have given the correlations between age and the remaining physical characters for both boys' and girls' departments of two schools.

TABLE XLIII.

THE RELATIONSHIP BETWEEN AGE AND VARIOUS PHYSICAL CHARACTERS.

		School Number.			
Character correlated with Age.	Method.	No. 7.		No. 11.	
		Boys.	Girls.	Boys.	Girls.
Teeth	Correlation Ratio	+·12±·03	+·20±·03	+·24±·03	+·14±·03
Condition of Clothing	" "	+·25±·03	+·19±·03	+·11±·03	−·02±·03
State of Cleanliness	" "	+·24±·03	+·18±·03	−·07±·03	+·06±·03
Hearing	Fourfold Table	+·18±·03	+·43±·03	−·00±·03	−·25±·03
	Two-row Method	+·08±·03	+·35±·03	+·10±·03	−·23±·03
Nutrition	Fourfold Table	+·53±·03	+·25±·03	+·41±·03	+·04±·03
	Two-row Method	+·46±·03	+·22±·03	+·35±·03	+·06±·03
Tonsils and Adenoids	Fourfold Table	+·14±·03	−·18±·03	+·21±·03	−·03±·03
	Two-row Method	+·08±·03	−·14±·03	+·12±·03	−·09±·03
Cervical Glands	Correlation Ratio	+·27±·03	+·07±·03	+·06±·03	+·24±·03

In the case of the power of hearing, the state of nutrition and the condition of the tonsils and adenoids, these have been worked out by two methods, the fourfold table and Professor Pearson's new two-row method already referred to. There is, however, very little significant difference between the results found by the two methods.

The interpretation of the results given in Table XLIII is by no means easy. Throughout, a positive sign indicates that, with increasing age, the condition of the character under consideration improves, while if greater age is associated with a worse condition a negative sign is prefixed. In no case are the correlations found consistent among the four departments considered, and in several cases we find significant positive values in the boys' department of a school, and significant negative values in the girls' department of the same school. Thus for the relationship between age and the condition of the tonsils and adenoids, in School No. 7, we get a correlation of +·14 among the boys, and −·18 among the girls. The correlation between age and the power of hearing is +·43 among the girls of school No. 7, and −·25 among the girls of No. 11. It is not safe, then, in view of these contradictory results to attempt to draw any deductions from them at present.

(17) Conclusions.

In starting this investigation I expected to find that the correlations which measured the influences of physique and home on mental capacity would be large, possibly exceeding ·5. I anticipated that stunted growth, as measured by height and weight less than the average, that defective nutrition, and that bad home environment, as measured by uncleanliness and defective clothing, would be found to be seriously detrimental to the growth of intelligence. I expected that physical defect, as measured by swollen glands, enlarged tonsils and adenoids, bad teeth, and poor hearing, would be closely associated with poorer intelligence. The mean values found for all those cases are given in Table XLIV. It is impossible on the basis of the

TABLE XLIV.

Mean Values of Correlations between Mental Capacity and Characters measuring Physique and Home Environment.

Character correlated with Mental Capacity.	Boys.	Girls.	Character correlated with Mental Capacity.	Boys.	Girls.	Character correlated with Mental Capacity.	Boys.	Girls.
Height	+·10	+·07	Clothing	+·04	+·24	Glands	+·09	+·08
Weight	+·06	+·03	Cleanliness	+·14	+·07	Tonsils, &c.	—·01	+·11
			Nutrition	+·01	+·08	Teeth	+·08	+·09
						Hearing	+·03	+·17

present statistics to assert that defective intelligence has largely its source in unfavourable home environment or in defective physique. The mean values are somewhat larger for girls than for boys, but they are so small for both that it is quite impossible to assert that the conditions dealt with in this investigation are the sources of the differentiation as to intelligence which we find between one child and another. Even the small values we have found for the average of all the schools become less satisfactory when we follow them up into their component values in the individual schools. There we see a great want of steadiness in the values. Many of the correlations found are not sensible (say less than two or three times their probable errors), others are sensible but small, but the signs are very irregular, and often in the same school the boys will show increased intelligence and the girls less intelligence with bettered environmental factors or physique, or vice versa. It might be said that this is due to personal equations of teacher and medical man; some of it may be so, but results, yet unpublished, of somewhat similar surveys, by different men and with different methods, at Edinburgh, Glasgow, and Aberdeen, which have been reduced in the Francis Galton Laboratory, point to identical conclusions. There is little sensible effect of nurture, environment, and physique on intelligence. Some such effect probably does exist, but it is clearly so small

that only very accurate and extremely numerous observations based on homogeneous material are likely to lead to results persistently sensible having regard to their probable errors.

Accordingly we may sum up the results of this pioneer survey as follows:

(i) There is evidence of much personal equation in both teachers and medical officers. This would be of little importance if the numbers examined by each pair were sufficiently large to obtain results sensible with regard to their probable errors. They are not, however, and the results show small average values with much instability.

Standardization of teachers' judgement and of medical officers' classification is absolutely needful if homogeneous material is to be obtained in sufficient quantity to demonstrate the existence of small associations between mental capacity, physique, and environment.

(ii) There is an urgent necessity in future surveys for a better and more absolute measure of intelligence. It is suggested that a careful verbal definition of each category should be given, and that this should be correlated with place in standard corrected for age. If this correlation were high, we should reach a satisfactory measure of general intelligence. The use of numbers as a scale of order without a very careful definition of the categories is not to be recommended, because it seems likely to lead to hasty classification. A great improvement would probably be effected if the teacher, when classifying for intelligence, were to place all the children of the same degrees of intelligence in groups so as to use the relative intelligence of the children as a check.

(iii) It is extremely doubtful whether the condition of the clothing or the cleanliness of a child are satisfactory measures of its home environment; the fact that when we correlate those conditions with intelligence we find a difference of *sign* between the boys and girls of the same school seems to indicate that the common factor, home environment, is not accurately measured by them, or that some, at present unknown, sex correction must be made.

There can be no doubt that the problem of the influence of home environment on the mentality and physique of the child can only be satisfactorily dealt with when the school survey by teachers and medical men is accompanied by a home survey by competent sociological observers.

It seems then that these facts are themselves sufficient to demonstrate the value of this pioneer survey. If they are disregarded in future surveys it is quite certain that much effort will be wasted if these lessons have to be relearnt.

(iv) But, further, the diversity of the recording systems used in this pioneer survey are not opposed to but provide data which justify us in our general conclusion that no close and significant relationship holds between mental capacity and the factors discussed.

Home environment, as measured by clothing, cleanliness, nutrition, stature,

and weight, cannot be the chief determining cause of the differentiation of intelligence; nor is defective physique its source. Some contribution unfavourable home environment and defective physique may make to the degree of intelligence, but even if finally demonstrated, it will be found to be a "second order" contribution, possibly even an indirect effect of race and stock, the abler children being those of fitter parents who give them better homes and better physique. Other factors of environment have yet to be discussed, but so far—and this generalization covers much more than the 400 coefficients calculated in this memoir disclose—there is no sign of an environmental condition producing an effect on the mentality of the child at all comparable with the known influences of heredity.

In conclusion, I must acknowledge the friendly assistance given by Miss Elderton and Miss Barrington in calculating some of the coefficients here recorded.

To Professor Pearson it is more difficult to express adequately my gratitude for his constant advice and assistance during the work on this paper.

UNIVERSITY OF LONDON

FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS. X.

A FIRST STUDY OF THE INFLUENCE OF PARENTAL ALCOHOLISM ON THE PHYSIQUE AND ABILITY OF THE OFFSPRING

BY

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A FIRST STUDY OF THE INFLUENCE OF PARENTAL ALCOHOLISM ON THE PHYSIQUE AND ABILITY OF THE OFFSPRING

BY

ETHEL M. ELDERTON,
GALTON RESEARCH SCHOLAR

WITH THE ASSISTANCE OF
KARL PEARSON, F.R.S.

WITH 8 DIAGRAMS IN TEXT.

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CONTENTS

PREFATORY NOTE

In issuing this second edition of our First Study to meet the very great demand there has been for it, we had the alternative of recasting the whole paper in order to meet the objections of critics, or of leaving it in its original form. We have preferred the latter course, partly because on re-reading our own paper it appeared to us that a careful study of our text and tables really supplied the answers to most of the criticisms which, not being of a rhetorical and unscientific character, deserve to be considered, and partly because the only rebutting evidence cited by critics is not closely allied to our present form of investigation and therefore has been dealt with at length in a separate study.

E. M. E.
K. P.

A First Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring.

(1) *Introduction.* An attempt is made in this paper to measure the effect of alcoholism in the parents on the health, physique and intelligence of their offspring. The question of intemperance is one of the chief problems of our national life, and as such it is beset with difficulties. It is surrounded with prejudices and has been too often treated with rhetoric, so that it is extremely difficult to free the mind from preconceived opinions and approach the subject with a purely judicial and calm statistical spirit. Yet if we are to deal with the drink question in a satisfactory and permanent fashion, reform must be guided by an instructed public opinion. No greater evil is done to a good cause, than when statistically undemonstrable statements receive, owing to emotional appeals, general credence, and then wider experience shows them later to be inexact. Nor again when we demonstrate that certain social results do not flow from alcohol, ought we to be charged with asserting that other results which we have not considered may not be directly due to it. The desire to know before acting, and the mind which refuses to express an opinion before knowledge, are so unfamiliar to many workers in the field of social reform, that the possibility of starting an inquiry without any bias as to its result seems to them almost an iniquity, the mark of an abnormal temperament.

Students of eugenics are not measuring the effect of any occupation or habit on the individual, but the effect that such occupation or habit may have on the racial qualities of future generations. They are not concerned with the effect of drink on the person who drinks, but they are concerned with the results that drinking produces in the offspring. These results may be due to three different sources:

(i) Alcoholism in the parent may, like insanity, be the somatic mark of a defective germ plasm in the stock. The child is defective not because the parent is alcoholic, but because it is the product like the parent of a defective germ plasm. The child may be physically and mentally fit, and yet when adult may exhibit alcoholic tendencies. This is the direct heredity of alcoholism. It is a subject not touched on in this paper, although material for its discussion is accumulating in the Galton Laboratory. It may be demonstrable to the hilt, and possibly justify the seclusion of the alcoholic; it does not occupy us, however, in this present study; we are concerned only with the offspring of the alcoholic as *children.* An equally important point is the cross-heredity of alcoholism. If alcoholism is a mark of a defective germ plasm, that defect may take one form in one individual of the stock and another form in a second; such associated heredities are well known to the student of insanity and of human deformities. The fact that the parent is alcoholic may lead us to expect an

increase of imbecility, epilepsy or tuberculosis in the offspring. This matter is only indirectly touched on in the present paper. It is not easy to distinguish such cross-heredity from our second source of alcoholic influence.

(ii) Alcoholism in the parent may have no hereditary origin; it may be considered as a habit due to environment and not to constitution, the effect on the child may be due to an environmental influence and not to any cross-heredity. The former cross-heredity would have come into play, if the parent had been forcibly deprived during life of alcohol; the child would still have been defective. This second source of harm to the children would arise even in the case of a parent, who was non-alcoholic by heredity, but who became alcoholic by habit or environment. The source of harm to the offspring lies in an enfeeblement of the physique, or possibly of the germ plasm of the parents, owing to a toxic property of alcohol.

(iii) Alcohol may thirdly be the source of evil to the children, not because of physical changes wrought in the parents, but because of economic and moral changes produced in the home environment. Mental and moral degradation of the parents, distress and poverty in the home may and probably do follow in the train of intemperance. Money spent excessively on drink means less money spent on the necessities of life; it leads to neglect of the children, to unhappy homes, and to undesirable environment. In any consideration of the results of alcoholism these very obvious facts arrest our attention, and we are inclined to lose sight of the really fundamental question: What is the quantitative measure of these environmental influences on the physical and mental characters of the offspring? It seems useful to class the three sources of alcoholic influence of the parent under the categories: (i) Hereditary Influence (*a*) Direct, (*b*) Cross; (ii) Toxic Influence, and (iii) Environmental Influence.

With (i) (*a*) we are not at present concerned, but hope that it will be dealt with later. We are dealing only with children, not yet of an age to exhibit definite alcoholic tendencies. Between (i) (*b*), (ii) and (iii), it will be difficult to differentiate on the basis of the present material. But the necessity for differentiation will only arise, if we demonstrate a substantial correlation between alcoholism in the parent and defectiveness in the child. Should such a correlation exist, then for a permanent and valuable scheme of social reform it is needful above all things to ascertain whether it is the cross-heredity, the toxic influence or the environmental influence which is the source or chief source of the resulting harm to the child. Complete prohibition would not remedy the cross-hereditary influence, it could only be met by the prohibition of parentage for members of affected stocks. Complete prohibition would put a stop at once to the toxic influence; either complete prohibition, or the removal of offspring would meet the environmental influence. Surely it is worth while to get some light on these points, before we tackle this great problem of alcoholism. And if it should be that more extensive data confirm the results of this preliminary study would it not be of considerable importance to realise that we must look to other factors besides drink as potent sources of our social difficulties?

Some hesitation will no doubt be felt by some of our readers at the lay treatment of a problem of this kind. But the reply to this is two-fold. The medical man as

a rule has no opportunity of dealing with a random sample of the general population; it is the social worker who goes into the homes who alone can appreciate the extent of the drinking habit, and record the economic conditions of the working population. Individual medical men see, of course, much more of special and extreme cases, but it is not part of their duty to appreciate and report on random samples of the general population. In the next place but few medical men at present have either the statistical training or the statistical tastes needful for an inquiry of this kind. It must fall to those whose duty it is at present to inquire into the social condition of the people—i.e. the social worker—and to those whose occupation is the treatment of statistics. We believe firmly that the day must come when for the treatment of these great social problems a laboratory shall be adequately endowed in which it shall be possible for sociologically trained, medically trained and statistically trained minds to work side by side for their solution. But until that day dawns, it is not reasonable to postpone sociological inquiry until a medical diagnosis can be taken of each individual. Such a diagnosis would be of immense value as making our classification precise. But failing it we must content ourselves with such categories as are provided by a single worker, or by a system of workers trained on a common plan. Such categories as *sober, drinks, has drinking bouts*, are not final, but they at least enable us to see further than we can without the knowledge they convey. Accordingly by the term alcoholism in this paper is not necessarily meant the "chronic alcoholism" of medical literature. We believe that many, possibly the majority, of our drinking class would be found to suffer more or less from chronic alcoholism; they at any rate in the opinion of trained social workers—assisted by the judgment of police and employers—are drinking more than is good for them or their homes. On the other hand by "sober" is not meant total abstinence, but cases in which the use of alcohol is so moderate, if it exists, that it does not appear to interfere with the health of the individual or the welfare of the home. Such then is the distinction between "parent drinks" and "parent is sober" of the following investigation. "Parent has drinking bouts" denotes a third well-marked class from the standpoint of the social observer; namely periodic outbreaks of alcoholism usually marked when they occur by more obvious immediate detriment to health, and more intense destruction of home welfare, e.g. discharge from employment, or visits to the police court.

(2) *Characteristics of Alcoholic Parents.* In any attempt to study the results of environment we are at once met by many difficulties, which in some cases are insoluble owing to our lack of adequate data. We may measure the effect of some environmental condition and find it correlated with definite characteristics in the children. We may then assume the latter to flow from the former, whereas the environmental condition may be a result of a physical or mental condition in the parents, which in itself is hereditary. Thus the correlation may be solely a secondary hereditary effect. It is possible that the more virile members of the community habitually take more alcohol than the feebler members and we might thus be led to a spurious correlation between alcoholism and good physique in the offspring. Or, the more stupid members of the community may be those who take more alcohol, and we might thus be led to the result that parental drinking destroys the intelligence of the

offspring. One of the greatest needs of the time, as the school surveys will show, is to associate the survey of the physique and mentality of the children, not only with a survey of the homes, but with a survey of the health of the parents, and if possible with some anthropometric examination of the parents. This at present is not feasible. But how, failing it, are we to be certain that drinking parents may not be physically or mentally differentiated from sober parents, and therefore differentiation of the offspring a secondary hereditary result? Nay, it might even be argued that if drinking parents were physically and mentally fitter than sober parents, the equality in the physique and mentality of children of both types of parents was due to alcohol pulling down to the average a child who should have been above the average. The point may seem at first sight an unnecessary one to raise; but therein lies really a vital question to the student of modern statistical methods: What are the correlations of physique and intelligence with the drinking habit? The answer cannot be given on the data used in this paper, but there is other material in the Laboratory upon which an answer to this question can ultimately be based. The only light that can be thrown on this matter from our present data is an indirect one. The wages of the father are to some extent a measure of the general status as to physique and intelligence of the parent. A man who is physically and mentally unfit will hardly receive high wages, whether he be drunk or sober. Clearly the general tendency of drink must when it reaches a certain intensity tend to lower a man's wages. We should therefore expect to find the wages of the drinking man somewhat less than those of the sober man; if in addition he has defective physique and intelligence, we should expect to find them markedly less than those of the sober man. In certain special cases no doubt peculiar skill in craftsmanship may lead to high wages and high wages to alcoholism; but the maintenance of high wages under such conditions can only be very exceptional and can only affect individual cases and the average but little. We think it may be safely affirmed that if the alcoholic parent were markedly inferior in physique or intelligence his average wages would be markedly less than those of the sober parent. Now in part of the material dealt with in this paper, the Edinburgh data, the wages are given in nearly every case. Parents were divided into three classes: (1) both parents drink, (2) one parent drinks and (3) neither parent drinks. The mean wage of the father when both parents drink was 24*s.* 8*d.*; when one parent drinks 25*s.* 6*d.* and when neither parent drinks 25*s.* 5*d.* Or, grouping in another way, when either or both drink 25*s.* and when neither drink 25*s.* 5*d.* If we consider the father alone, for it is not possible to apply the wages test to determine the drinking mother's status in comparison with other mothers, we find that the wages of a drinking man are on the average 25*s.* and a non-drinking man 26*s.* It would be reasonable to suppose that the 6*d.* or 1*s.* difference shown in the above results is what the employer is willing to pay for the convenience of sobriety. It can hardly mean that there is a great differentiation in physique and intelligence between the alcoholic and the non-alcoholic*. At any rate if the alcoholic are physically and mentally inferior, one might expect this fact together with the inconvenience of insobriety would be indicated by a higher wage difference. Of course

* A reply to Professor Marshall's criticism of these wage-results will be found in *Questions of the Day and the Fray*, No. I, Dulau & Co.

a somewhat higher physique or intelligence in the alcoholic might be screened by their habits giving them a lower market value. On the whole it seems reasonable to assume that the drinking parents are in physique and mentality the equal on an average of the sober, or possibly a little above their standard. This possible slight difference will hardly sensibly affect the correlations between parental alcoholism and the health and intelligence of the children.

(3) *Material.* We have used for the purposes of this paper two series of statistics bearing on the question of drink and its effect on the children; the Edinburgh Charity Organization Society Report and a manuscript account of the children in the special schools of Manchester provided for us by Miss Mary Dendy*. In dealing with the children in these special schools it must be remembered that we are considering a selected class of homes; of the children in these homes one at least is mentally defective. In the families chosen for investigation by the C.O.S. in Edinburgh the selection is much less stringent; the homes of all the children attending a certain school in Edinburgh were examined and the school was chosen because "It has upon its rolls children from the poorest parts of the city, and yet it has also an admixture of the substantially comfortable and thoroughly respectable working class," and the report goes on to say, "In the poorest part of a city of many centuries' growth there are also many 'old families' who continue to reside in the houses their fathers and grandfathers lived in, for old times' sake, despite of the degeneration of the immediate neighbourhood. This gives the school a widely representative character, which especially commended itself to the Committee in making its selection."

In the Manchester data the parents were divided into "temperate" and "intemperate" and information was given about the health and in most cases about the intelligence of the brothers and sisters of the mentally defective child.

In the Edinburgh report more details were given as to the degree and kind of drinking of the parents but the numbers are too few to enable us to use these divisions in detail, the tables in the Appendix give the numbers in each class. We were able to divide the parents into the following classes. Parent: (1) Teetotaller, (2) Sober, (3) Suspected to drink, (4) Drinks, (5) Has bouts of drinking. As will be seen from the tables, classes (1) and (3) were too small to be kept separate and teetotallers had to be included with sober people and suspected drinkers with drinkers.

We have worked out the correlation coefficients between the drinking of the parents and the actual height and weight of the children, their health, intelligence, diseases and eyesight and the effect on the infant death rate. In determining the drinking capacities of the parents we have used the account of each home given in the Report, in the same manner as we have done in other memoirs. It is a personal judgment, but one substantially repeated on going through the data a second time.

(4) *Drink of Parents and Height and Weight of Children.* We will first consider the effect of the drinking of the parents on the actual height and weight of their children. The tables are Numbers I to XVI inclusive in the Appendix. In this

* The material was collected by the late Dr Ashby, who personally saw one or both parents. The houses were visited by trained visitors.

case we first divided our statistics into two groups only, one or both parents drink and neither parent drinks and worked the correlations out by the new method discussed by Professor Pearson in *Biometrika*, Vol. VII. p. 96*. The first step in this method of finding a correlation coefficient is to find the means of the classes. We found that the mean height of the sons of non-drinking parents was 47·5 inches and of the sons of drinking parents was 47·9 inches and the correlation was ·07, that is to say a very slight connection between drinking parents and taller sons and we found much the same for weight; the mean weight of the sons of non-drinking parents was 53·8 lbs. and of the sons of drinking parents was 55·0 lbs. and the correlation between drinking parents and heavier sons was found to be ·06. We had to put all ages together so we had next to correct for the correlation between the drinking of the parents and age of the children†.

We found that the mean age of the sons of non-drinking parents was 9·4 and of drinking parents was 9·8 and the correlation between drinking parents and older sons was ·11. Using the formula for partial correlation we found that the coefficient between drinking parents and poorer physique in their sons for a constant age was ·04 for height and ·05 for weight. The results are given in Table I for girls and boys.

TABLE I.

					Correlation coefficients			Partial correlation coefficients	
		Mean height	Mean weight	Mean age	Drink and height	Drink and weight	Drink and greater age	Drink and height for constant age	Drink and weight for constant age
Boys	Parents sober	47·5	53·8	9·4	− ·07	− ·06	·11	·04 ± ·03	·05 ± ·03
	Parents drink	47·9	55·0	9·8					
Girls	Parents sober	46·8	52·7	9·3	·03	·02	·03	·09 ± ·03	·08 ± ·03
	Parents drink	46·6	52·3	9·4					

The minus sign when it occurs means that a better condition in the child is correlated with drink in the parent.

The results differ slightly for girls and boys as the table shows, and in the final results given in the last two columns we see that the correlation coefficient between drinking and less height is ·04 for boys and ·09 for girls and between drinking and less weight is ·05 for boys and ·08 for girls.

This is a case where a probable error is a necessity in order to enable us to judge whether these results are significant. The probable error for the partial correlation coefficient has been shown‡ by Mr Heron to be the same in form as for the absolute

* "On a new method of determining correlation between a measured character *A*, and a character *B*, of which only the percentage of cases wherein *B* exceeds (or falls short of) a given intensity is recorded for each grade of *A*."

† i.e. as the parents grow older, the children grow older, and some alcoholism develops with the parents' age.

‡ *Biometrika*, Vol. VII. Part III.

coefficient and it is equal to ·03 in each of the above cases. With a probable error of ·03 one can only say that values of ·04 and ·05 are insignificant and only slight significance attaches to values of ·08 and ·09.

We next separated the father and mother and worked out the correlations between the father's drink and his child's height and weight and between the mother's drink and her child's height and weight; the results are given in Table II.

TABLE II.

		Correlation coefficients					Partial correlation coefficients	
		Drink and height	Drink and weight	Drink and greater age	Age and height	Age and weight	Drink and height for constant age	Drink and weight for constant age
Sons	Father	– ·04	– ·05	·08	·81	·81	·04 ± ·03	·04 ± ·03
	Mother	– ·01	– ·01	·07	·81	·81	·08 ± ·03	·08 ± ·03
Daughters	Father	·03	·04	·00	·81	·82	·03 ± ·03	·04 ± ·03
	Mother	·02	·03	·07	·81	·82	·13 ± ·03	·14 ± ·03

The last two columns give the final results, i.e. the correlation between the drink of the father and mother and the height and weight of their children. The drinking of the mother is seen to have more effect on her child's physique than the drinking of the father. There is practically no correlation between the father's alcoholism and his child's physique for either boys or girls, but there is a connection between the mother's alcoholism and her child's physique, and this connection appears to be greater for girls than boys. The last fact makes it very difficult for us to assert that the slightly poorer physique is a result of a toxic influence. There is no reason to suppose that such would affect the male less than the female; it is far more probably due to the factor of undesirable home environment; the alcoholism of the mother throws more home duties on the girl-child; lessened care would affect boy and girl alike and probably does so. Some of the greater influence of the alcoholic mother as compared with the alcoholic father may be due to the fact that alcoholism in the mother is correlated with another environmental factor, which we have found associated with slightly lessened physique in the offspring, I refer to the employment of the mother. From the Edinburgh Report we find that 43·6 °/$_{\circ}$ of drinking mothers are employed and only 26·4 °/$_{\circ}$ of sober mothers; the correlation between employment and drink is ·28. We have thus distinct evidence that alcohol quite apart from any toxic effect is associated with a modified home environment*. If we allowed for this fact of greater employment of alcoholic mothers we should find some reduction in the intensity of the correlation of maternal alcoholism and physique of offspring, but it would not account for the whole value. It is chiefly of interest as showing that we cannot conclude from a correlation of the child's physique and parental alcoholism the

* It is also conceivable that the alcoholic mothers are racially differentiated, and this would produce a physical differentiation in the offspring of alcoholic mothers.

existence of a toxic effect until we have considered how far the parental alcoholism is associated with differentiation in the occupations or habits of the parents—shortly with environmental differences, which do not necessarily flow even from the alcoholism, but may like the mother's employment be possibly the source of the alcoholism itself.

We may we think infer from the above results that the father's alcoholism has no sensible influence on the physique of the child. The mother's alcoholism has a small but quite sensible influence on the height and weight of the child, more sensible in the case of the girl than the boy. It is probably due, not to any toxic effect of the alcoholism, but to increased unfavourable home environment. Even where the relation is the highest, i.e. ·14, it has only about $\frac{2}{7}$ the intensity of parental heredity.

(5) *Parental Alcoholism and General Health of Offspring.* We will next consider the general health of the children of alcoholic parents. The tables are numbers XVII to XXIV inclusive in the Appendix.

(i) *Manchester.* From Miss Dendy's manuscript account of the children in the special schools of Manchester* we have been able to divide the health of the brothers and sisters of the defective child into the following classes: (*a*) Normal, (*b*) Delicate, (*c*) Phthisical and Epileptic, (*d*) Died young of "fits," "wasting" etc. The parents in this case could be divided into two classes only, those who are temperate and those who are intemperate. The percentages of children of temperate and intemperate parents having the different grades of health are given below.

		Father temperate	Father intemperate
Son	Healthy	57·8	59·2
	Delicate	14·8	15·8
	Epil. & Phth.	9·1	4·3
	Died young...	18·3	20·7

		Father temperate	Father intemperate
Daughter	Healthy	57·2	61·7
	Delicate	14·8	13·9
	Epil. & Phth.	6·1	3·9
	Died young...	22·0	20·5

		Mother temperate	Mother intemperate
Son	Healthy	57·5	61·7
	Delicate	15·0	19·4
	Epil. & Phth.	5·3	2·2
	Died young...	22·2	16·7

		Mother temperate	Mother intemperate
Daughter	Healthy	59·0	57·6
	Delicate	14·7	18·2
	Epil. & Phth.	8·4	3·0
	Died young...	18·0	21·2

It will be seen from these percentages that the differences between the health of the children of temperate and intemperate parents are very slight having regard to the numbers available and there is a certain amount of irregularity. The only fact that is constant throughout the four tables is the larger percentage of children suffering from epilepsy and phthisis among the children of temperate parents and an examina-

* The medical details of this account were prepared under the control of the late Dr Ashby.

tion of the curves (p. 10) shows this very clearly. In three out of four cases we find a slightly larger number of healthy children among the children of intemperate parents and a slightly larger number of delicate; in the "died young" class we find in two cases the larger number among the children of intemperate and in two cases among the children of temperate parents. It is obvious from these tables that the correlations will be very small and that it will be difficult to decide whether, taken as a whole, they are to be considered positive or negative, i.e. whether the connection is between intemperance and bad health or between intemperance and good health.

These correlations have been worked out in two ways: (i) by a method giving η which will be discussed by Professor Pearson in the next number of *Biometrika* * and (ii) by the fourfold method giving r. In using the fourfold method we grouped "delicate," phthisical, epileptic and "died young" together. In using the first method we grouped phthisical and epileptic together. It may be objected that it is not legitimate to group in this manner, but the number of phthisical children is too small to keep them separate and for both diseases there is a distinctly greater percentage in the temperate group; it seemed therefore better to group the phthisical with the epileptic children than to group phthisis with delicate where this predominance does not occur. In the tables in the Appendix, the original numbers in the two classes are given. See Tables XVII to XX inclusive.

	Correlation ratio, η†	Correlation coefficient, r, by fourfold table
Drink of father and health of son	·07	−·06
Drink of father and health of daughter	·12	−·04
Drink of mother and health of son	·14	−·07
Drink of mother and health of daughter	·15	−·03

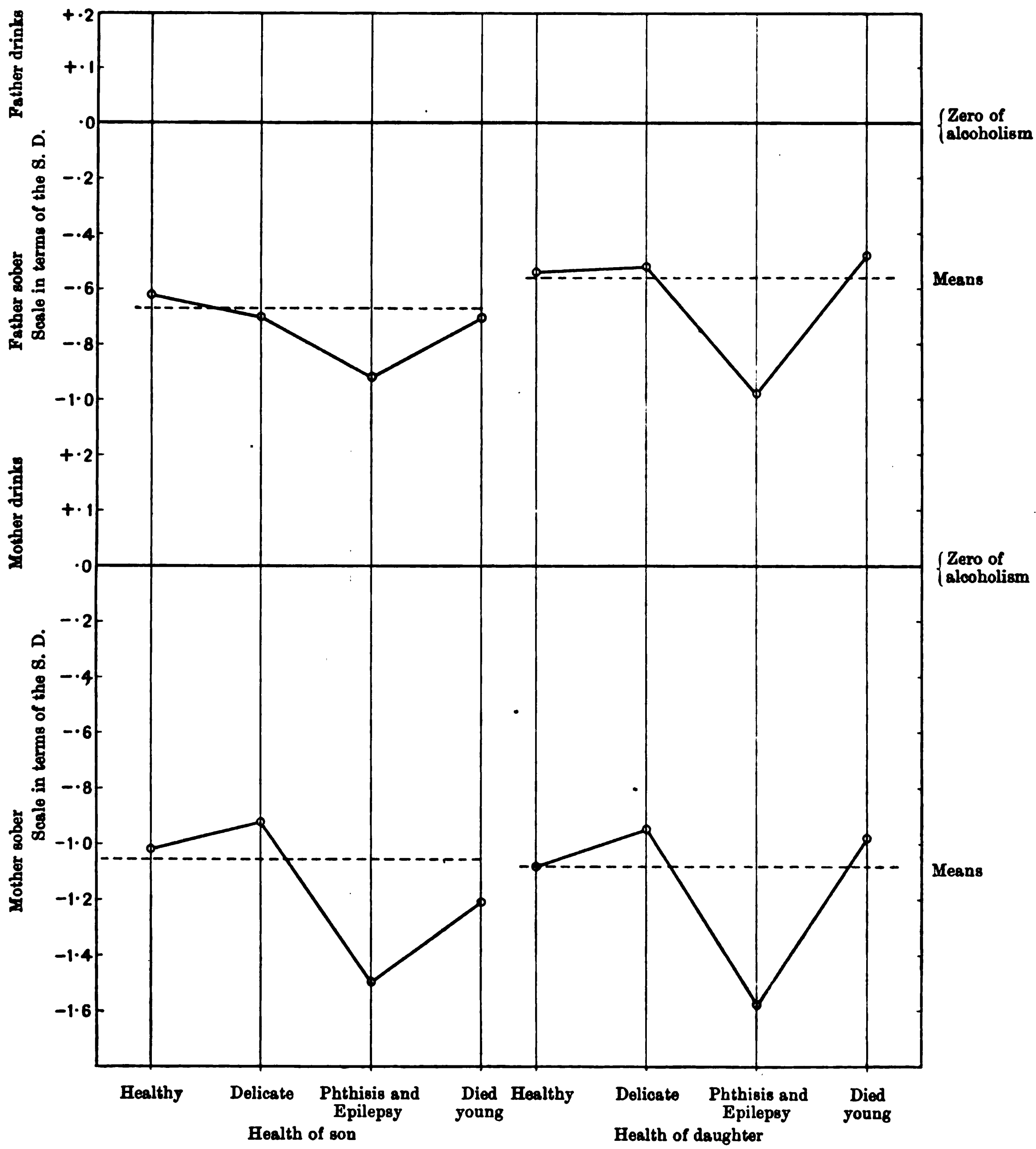
An examination of the curves on p. 10 will indicate the source of the divergence in the results by the two different methods. These curves show the mean alcoholism of the parents for each grade of health (intelligence, etc.), in the children measured by the deviation from the dividing line between alcoholic and sober parents. The dividing line is drawn in each case; the further below this line any point is situated the more sober is the parent and the deviations will have a minus sign; the further above this line the more drunken is the parent and the deviations will be positive. The vertical scale is measured in terms of the Standard Deviation. The dotted line shows the average amount of alcoholism in all the parents of the children under consideration. Sobriety is thus on the diagrams a negative alcoholism. The average Manchester and Edinburgh mothers are sober, the average Manchester father is also sober, but not the average Edinburgh father. The standards of the recorders have, of course, to be allowed for, but there is good reason to believe that the Edinburgh

* Vol. VII. p. 248: "On a New Method of determining Correlation, when one Variable is given by alternative and the other by multiple Categories."

† The reader will bear in mind that the correlation ratio has no sign by its nature and is only equal numerically to the correlation coefficient when the regression is linear.

population is really as well as apparently more alcoholic than the Manchester. It will be seen that it is the dip into the sober class of parent of epileptic and phthisical children which is the source of the higher value found for η, and in the only case where this dip is slight the two values found by η and the fourfold method agree well numerically. The number of phthisical and epileptic children is comparatively few and we should probably be nearer the truth if we take the lower values given by the fourfold method for the influence of drink on general health. The value found is negative,

FIG. 1. PARENTAL ALCOHOLISM AND HEALTH OF CHILDREN (MANCHESTER).



that is to say, parental intemperance is not associated with relatively worse general health in the children but a coefficient even of ·07 with a probable error of ·03 is not really significant, and we should say that as far as these statistics go there is no general association between parental alcoholism and defective health in the children. The nature of the interrelationship is far more subtle than we think many temperance advocates have realised. The fact, as shown in these figures, that the children of the intemperate are healthier than the children of the sober is probably due to the more virile and physically fit members of the community being liable to alcoholic temptation, and is as such an indirect effect of heredity and not a result of alcohol. The greater percentage of phthisical and epileptic children in the families of the sober is again probably due to the same source; i.e. these pathological conditions arise from inherited constitutions, and the parents of phthisical and epileptic children being themselves of a feebler constitution than average parents are less liable to alcoholism. It may further be noted that in the case of children dying young, while for sons the parents of both sexes are more sober than the average, for girls they are more alcoholic than the average; this appears to mark the result as due to an environmental rather than a toxic influence, and corresponds to what we have noticed in the relation of weight and height of children to parental alcoholism. Taking health as a whole we are compelled to say, that—excepting that phthisis and epilepsy occur less frequently with alcoholic parents—there is no significant association between parental alcoholism and defective health in the offspring. The differences are far too slight to permit of safe conclusions being drawn, and there is no intense and close relation between alcoholism and defective health or pathological condition in the offspring.

(ii) *Edinburgh.* We may now consider how far the data obtained from the Manchester special schools receive confirmation from other sources, and we turn to the data collected by the Edinburgh C.O.S. to find independently the relation between the drinking of the parent and the health of the children. In the Edinburgh report the general health is not stated for each child but the diseases from which each child suffers are given and upon this we are able to divide the children into various classes, i.e. healthy, suffering with glands (tubercular glands were kept separate), epileptic, phthisical, weak chests, rickets, weak hearts, eczema, etc.; there were not sufficient cases to keep all these categories separate and we have had to content ourselves in the first place with making three divisions, i.e. (1) healthy, (2) suffering from glands, (3) suffering from other diseases. The percentages are given in the four tables below of children divided into these three classes; the drinking of the parents is also divided into three classes: Parent (1) sober, (2) drinks, (3) drinks in bouts.

Drinking in bouts seems to be much less frequent among mothers than fathers and the numbers in that class are rather too small to give regular results. Two facts seem to be clear from these tables: (1) the larger percentage of children suffering with glands when the parents drink in bouts and (2) the larger percentage of children suffering from "other diseases" when the parents are sober. The associations worked out by contingency are Father and son ·11, Mother and son ·12, Father and daughter,

·05, Mother and daughter, ·14. Here again it is extremely difficult to tell what the sign should be and in order to ascertain it we divided the "other diseases" into three classes, those suffering from (1) heart, (2) chest and bronchial troubles, (3) other diseases which include rickets, eczema, curvature, delicacy, etc. and, in order to have a sufficient number of cases on which to base means, the two sexes were put together and the correlation ratios worked out for father and child and mother and child by the recently published method* The correlation ratios were ·14 in each case but an examination of the means shows a curious difference. In the case of the mothers the means show a general downward tendency which indicates an increasing number of children suffering from heart, chest and other diseases in the sober class of mothers; but when we examine the curve for fathers we see an upward slope of the curve into the drink class except for "other diseases" when there is a very decided drop into the

Father

Son	Sober	Drinks	Bouts
Healthy	31·6	32·9	27·3
Glands	40·2	39·6	50·0
Other diseases	28·2	27·4	22·7

$C = \cdot 11$

Father

Daughter	Sober	Drinks	Bouts
Healthy	32·1	31·9	29·2
Glands	43·5	45·4	50·0
Other diseases	24·4	22·7	20 8

$C = \cdot 05$

Mother

Son	Sober	Drinks	Bouts
Healthy	32·1	30·2	25·5
Glands	39·2	47·3	55·3
Other diseases	28·7	22·5	19·1

$C = \cdot 12$

Mother

Daughter	Sober	Drinks	Bouts
Healthy	28·4	35·9	19·4
Glands	42·5	46·4	50·0
Other diseases	29·1	17·6	30·6

$C = \cdot 14$

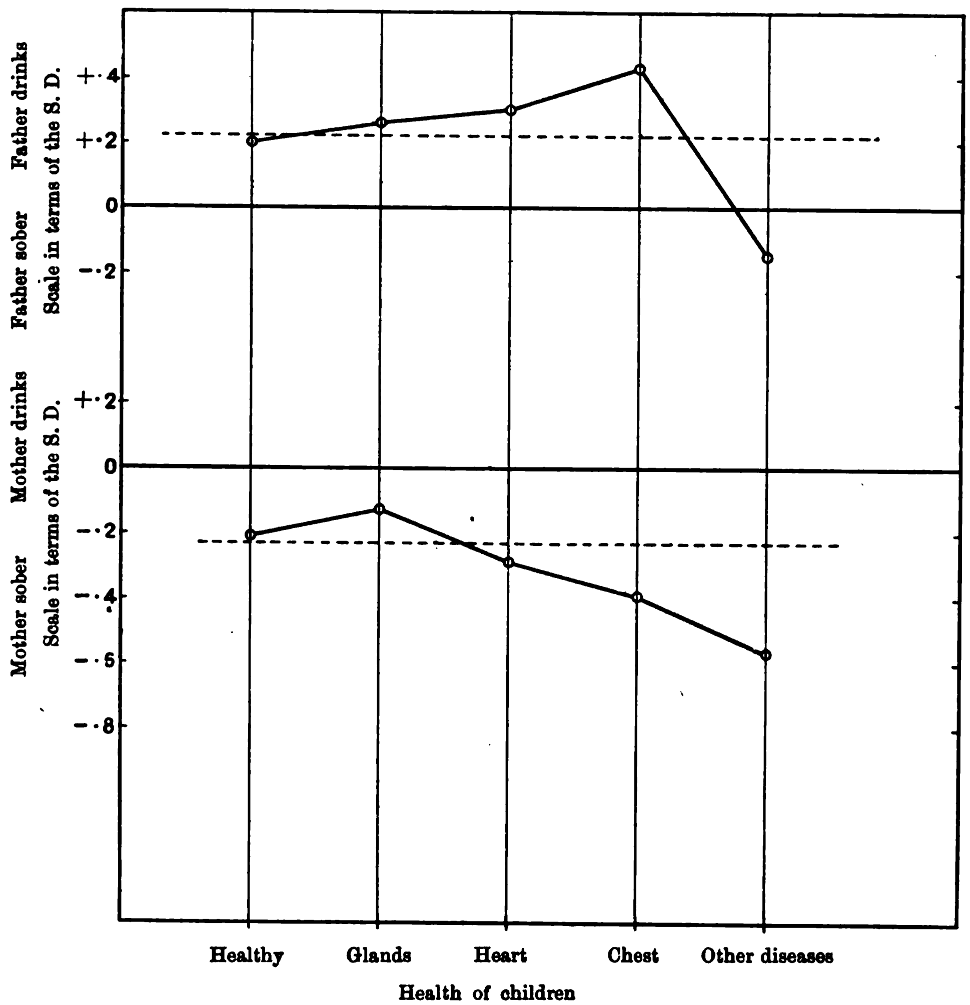
sober class of fathers. It is very difficult to trace definite relationships here; they are too slight in character to be really significant on the basis of the numbers dealt with; they seem to be different for parents of the two sexes and again for offspring of the two sexes. The only definite conclusion that can be drawn is that there is no close and simple relation between parental alcoholism and defective health in the children, which can be ascertained from a sample of moderate size of the general population. There may exist slight and complex relations as indicated by the fact that "other diseases" show a significant tendency to be associated with parental sobriety rather than with parental alcoholism.

(6) *Parental Alcoholism and Intelligence of Children.* See Tables XXV to XXXV inclusive in the Appendix. First we will consider the results obtained from the Manchester special schools. In this case we could only divide the children into

* See footnote p. 9.

(1) mentally defective and (2) normal. There were a small number of children who were very dull, without apparently being actually defective, but these we included in the mentally defective category as they were certainly not normal, but the number of them being only 1 per cent. of the whole number of children the transference from one group to the other would make practically no difference to the correlation coefficient. The percentages tables are given on p. 14, and the correlation coefficients worked by the fourfold method, the only available method in this case, are given below each table.

FIG. 2. PARENTAL ALCOHOLISM AND HEALTH OF CHILDREN (EDINBURGH).



Of the four tables three show a negative correlation, that is to say a correlation between temperate parents and mentally defective children; the correlation coefficients are too small to be of great significance but they show very clearly that the statement that intemperance in the parent causes mental defect in the children must be received with caution; it is not the case among the defectives in Manchester. When the father is temperate we find 41 per cent. of his sons and 31 per cent. of his daughters

are mentally defective, which must be compared with 34 per cent. and 30 per cent. when he is intemperate. When the mother is temperate we find 39 per cent. of her sons and 30 per cent. of her daughters are mentally defective, which must be compared with 40 per cent. and 24 per cent. when the mother is intemperate. Here again we must repeat that we do not suppose temperance to be a cause of mental defect any more than we supposed it to be a cause of phthisis or epilepsy. The small association, if it be significant, is probably a secondary effect of an hereditary influence, the mentally defective children coming from a feebler stock, which has not the desire or possibly the capacity for alcohol of a stock of a more vigorous physique.

Father

		Temperate	Intemperate
Son	Normal	58·8	65·8
	Mentally defective	41·2	34·2

− ·11

Father

		Temperate	Intemperate
Daughter	Normal	69·2	70·5
	Mentally defective	30·8	29·5

− ·02

Mother

		Temperate	Intemperate
Son	Normal	60·8	60·0
	Mentally defective	39·2	40·0

·01

Mother

		Temperate	Intemperate
Daughter	Normal	69·9	75·8
	Mentally defective	30·1	24·2

− ·08

The above data are of course selected, they only show the relationship of alcohol and mental defect within families, one member at least of which is mentally defective.

We shall next deal with the non-selected data obtained from the Edinburgh school. As before we will first give the table in the form of percentages, and the association found by the two methods of contingency and of the correlation ratio is placed below each table.

In examining the tables it must be remembered that children with "excellent" intelligence are few in number and we shall consequently find some irregularity in this class, and as those parents who drink in bouts are fewer in number than either "sober" or "drinkers" so we shall find more irregularity in the percentages in the bout class. It is probably due to the smaller numbers that we find in the first table, 12 per cent. "excellent" boys when the father drinks in bouts, while there are only 3 per cent. of "excellent" girls in the second table. As far as the sober and drinking parents are concerned we find that excellent intelligence in their children is very evenly divided; there is a slight excess of excellent intelligence among the sons of temperate fathers but in the other three cases we find a slight excess of excellent intelligence among the children of drinking parents. When we examine the percentages of children with good intelligence we find a slight excess of good intelligence among the sons of drinking parents and a slight excess of good intelligence among the daughters

of non-drinking parents. In the category of dull and defective intelligence we find an excess among the sons of sober fathers and in the other three tables we get the excess of dullards in the children of drinking parents. The differences throughout are slight and irregular and the correlation coefficients are only just significant. In this case as in the case of health we worked the tables a second way and found η and plotted the mean deviations in order to find what sign to attach to these values—drinkers and bout drinkers were classed together. The values for η are given below those found by contingency, and it will be seen that the correlations are scarcely significant.

Father

Son	Sober	Drinks	Bouts
Excellent	7·9	5·4	12·5
Good	37·3	39·0	30·7
Medium................	34·7	38·1	42·0
Dull and defective...	20·1	17·4	14·8

$C = \cdot 14$
$\eta = \cdot 07$

Father

Daughter	Sober	Drinks	Bouts
	6·0	6·3	3·3
	34·7	34·6	41·3
	41·7	38·5	38·0
	17·6	20·5	17·3

$C = \cdot 09$
$\eta = \cdot 05$

Mother

Son	Sober	Drinks	Bouts
Excellent	5·8	7·4	5·2
Good	37·9	40·1	43·1
Medium................	37·2	34·0	32·8
Dull and defective...	18·1	18·5	19·0

$C = \cdot 08$
$\eta = \cdot 05$

Mother

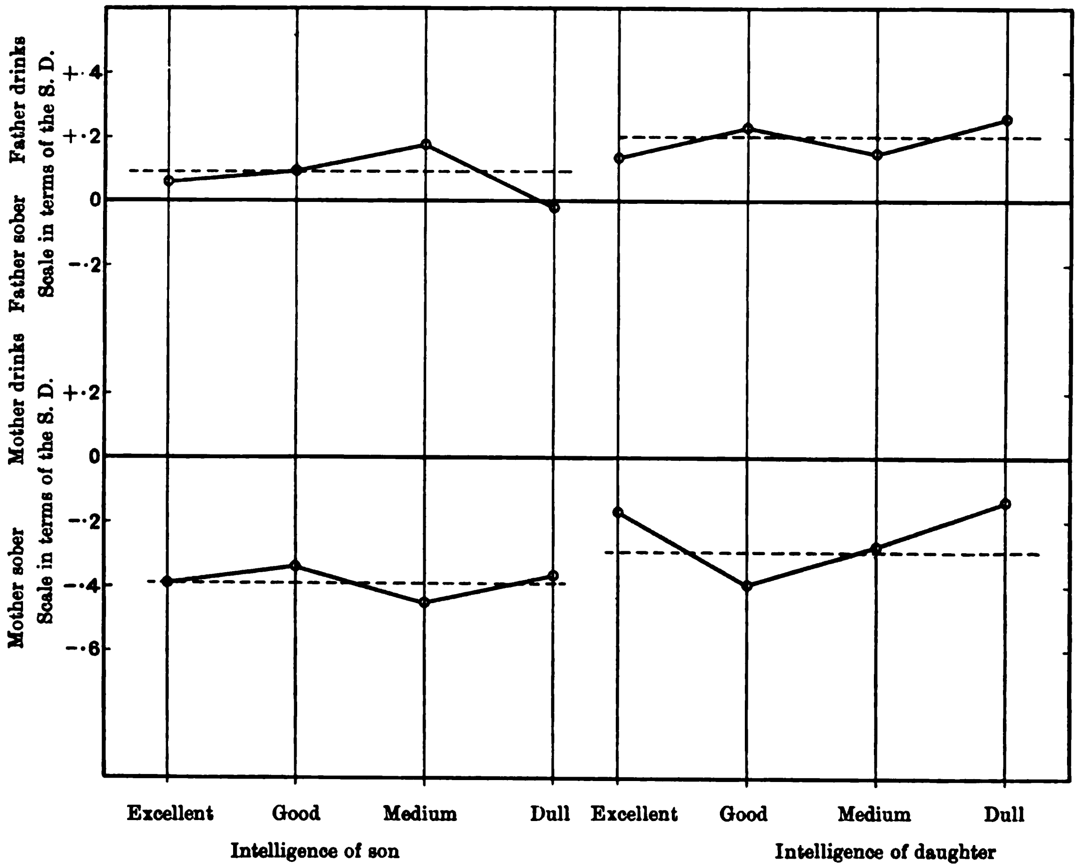
Daughter	Sober	Drinks	Bouts
	5·0	5·7	7·7
	39·4	33·0	33·3
	38·2	40·3	33·3
	17·4	21·0	25·6

$C = \cdot 09$
$\eta = \cdot 09$

It is almost impossible to determine whether the slight relationship noted above is to be considered positive or negative, i.e. whether temperance or intemperance of parents is associated with good intelligence in the offspring. We can bring this home to the reader in two ways. First the material was divided into four fourfold tables, the parents were divided into sober and drinking, the offspring into two groups excellent with good, and medium with dull. It was found that alcoholism of the parent went with the better intelligence of the offspring in the cases of father and son and mother and daughter, while in the cases of father and daughter and mother and son the reverse was the case. Even if any weight could be given to the extremely small correlations the difference of sign in the four correlations precludes our asserting any marked and simple relationship. Secondly the accompanying diagrams indicating the average alcoholic tendency of the parent of each class of child, obtained by Pearson's new correlation ratio method, show how small is the trace of any significant relation between parental alcoholism and filial intelligence—the deviations bear wholly the

impress of irregularity due to random sampling. The truth seems to be that there is no marked relation whatever between filial intelligence and parental alcoholism.

FIG. 3. PARENTAL ALCOHOLISM AND INTELLIGENCE OF CHILDREN (EDINBURGH).



(7) *Parental Alcoholism and Filial Eyesight.* Although on first consideration the reader may imagine the association of these characters is not a fruitful field for inquiry, it will ultimately be seen that there is much to be said about it, and that it opens up several lines of related investigation of peculiar interest. For example, the alcoholism of parents if productive of general degeneracy in the children, would be likely to be marked by defective filial eyesight. Again, alcoholic parents are peculiarly likely to neglect the cleanliness and care on which the hygiene of the eye largely depends. Further alcoholism in the home may drive the children out of doors, and thus even produce an environment favourable to the eyesight. Shortly there is no field in which, on a little careful consideration, it will be realised that we are likely to have such an interplay of the three fundamental influences of alcohol, the hereditary, the toxic and the environmental, as in the problems concerning filial eyesight and parental alcoholism. We have again in this case also very reliable medical data for the children's eyesight. These data concern (1) Refraction, (2) Acuity of Vision and (3) Diseases of the Eye and are drawn from the Edinburgh C.O.S. Report. In the first two cases,

Refraction and Acuity, we know that there is increasing defect with increasing age*. It is hardly likely, however, that the third case, Diseases of the Eye, will be much affected by the difference in average age of the children of alcoholic and non-alcoholic parents. Since the children of alcoholic parents are slightly older than those of sober parents†, we might expect on this ground alone their eyesight to be slightly worse,—and this quite independent of alcoholism.

Our first investigation will deal with the influence of parental alcoholism on filial refraction, and as before we give below the fundamental Tables (Appendix Tables XXXIII to XXXVI inclusive) in the form of percentage tables. The mean square contingency of the original tables is attached below the percentage tables. We see at once that the association, whatever analysis may show of its actual nature, is more uniform *numerically* and on the whole more substantial than those we have yet come across. It must be remembered in considering these tables that the actual numbers of children falling in the mixed astigmatism, myopic astigmatism and myopia classes are small, and that accordingly we must anticipate irregularities in our results.

Father

Son	Sober	Drinks	Bouts
Normal	59·6	74·2	63·3
Hypermetropia	20·7	12·4	17·9
Hyper. astigmatism	12·4	7·3	10·6
Mixed astigmatism	4·3	3·8	3·2
Myopia and myopic astigmatism	3·0	2·3	5·0

$C = \cdot 15$
$\eta = \cdot 13$

Father

Daughter	Sober	Drinks	Bouts
Normal	57·1	61·8	57·7
Hypermetropia	17·6	16·6	15·9
Hyper. astigmatism	13·9	16·6	15·9
Mixed astigmatism	6·3	2·7	5·5
Myopia and myopic astigmatism	5·1	2·4	4·9

$C = \cdot 11$
$\eta = \cdot 10$

Mother

Son	Sober	Drinks	Bouts
Normal	64·5	72·0	59·6
Hypermetropia	15·7	13·0	23·7
Hyper. astigmatism	11·4	12·4	9·6
Mixed astigmatism	4·2	1·2	4·4
Myopia and myopic astigmatism	4·2	1·2	2·6

$C = \cdot 16$
$\eta = \cdot 14$

Mother

Daughter	Sober	Drinks	Bouts
Normal	58·1	65·5	61·8
Hypermetropia	16·7	13·9	6·6
Hyper. astigmatism	15·2	13·0	15·8
Mixed astigmatism	6·6	4·5	9·2
Myopia and myopic astigmatism	3·4	3·0	6·6

$C = \cdot 13$
$\eta = \cdot 10$

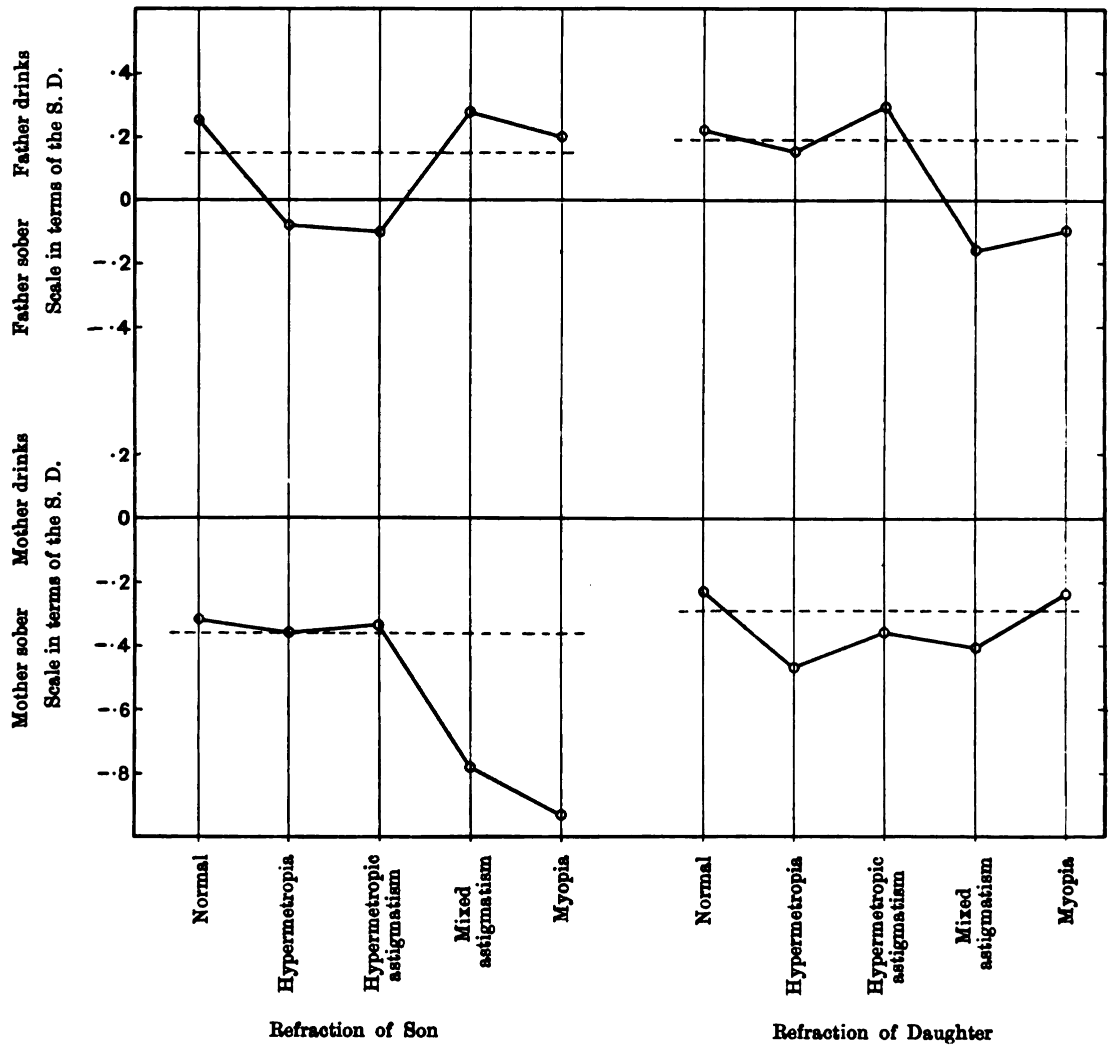
On examining these tables in the first instance we will leave the "bouts" out of the question and consider only the percentages of the different kinds of eyesight of

* "A First Study of the Inheritance of Vision and of the Relative Influence of Heredity and Environment on Sight." By Amy Barrington and Karl Pearson, F.R.S., *Eugenics Laboratory Memoirs*, Dulau & Co., 1909.

† This is probably due to the fact that some parents become more definitely alcoholic with age.

the child of the sober and drinking parents. Two facts are common to all four tables (1) the larger proportion of normal eyes among the children of drinking than among those of sober parents, (2) the larger proportion of children suffering from mixed astigmatism, from hypermetropia and from myopia and myopic astigmatism among the sons and daughters of sober parents. The only class of eyesight that shows any irregularity in the percentages is the hypermetropic astigmatism; in two cases we find a greater percentage of this eye defect in the children of sober parents and in two cases in the

FIG. 4. PARENTAL ALCOHOLISM AND REFRACTION OF CHILDREN (EDINBURGH).



children of drinking parents. If we leave "bout drinkers" out of the question there is no doubt that the correlation, small though it is, is negative and that temperance in the parents is associated with defective refraction in the children. When we consider the children of bout drinkers we find considerably more irregularity; in three cases out of four the percentage of normal children lies between the percentages found for sober and drinking parents, in the fourth case, that for mother and son, the per-

centage of normals is lower than the percentage found in the sober class, and in this same table there is a big increase in the number of children falling in the hypermetropic category; we find 24 per cent. as compared with 16 per cent. among the sons of sober and 13 per cent. among the sons of drinking mothers. In the case of bouts, however, the entries in some of the categories are too small to give reliable results. We next calculated η and for this purpose grouped drinking and bout drinking parents together; the values found for η will be seen to agree very well with those found by contingency.

The deviations from the mean, as shown in the curves on page 18, exhibit the results in another form. In two cases there is no doubt about the sign, it is negative, and temperance in the father is associated with worse eyesight in the daughter and temperance in the mother with worse eyesight in the son; and we think we must also consider the sign to be negative in the case of mother and daughter; the downward slope is not so obvious because of the upward direction in the myopia class, but even with this slope it does not reach so far into the drinking class as the mean parents of the normal children. Throughout the relationships are really small and clearly not simple in character so that not much stress can be laid on them; but as far as they go they show no definite and marked connection between intemperance and bad eyesight—the connection, if any, is rather between intemperance and good sight.

Before discussing this result further we may turn to the effect of the parents drinking on the acuity of vision of their children (Tables XXXVII to XL inclusive in the Appendix).

Father

Sons	Sober	Drinks	Bouts
6/6	66·1	77·1	67·9
6/9 and 6/12	20·5	11·7	14·7
6/18	10·2	6·5	11·9
Rest	3·1	4·7	5·5

$C = \cdot 14$

$\eta = \cdot 15$

Father

Daughters	Sober	Drinks	Bouts
6/6	63·8	64·6	67·5
6/9 and 6/12	21·3	21·2	16·9
6/18	9·7	10·1	9·0
Rest	5·3	4·2	6·7

$C = \cdot 11$

$\eta = \cdot 09$

Mother

Sons	Sober	Drinks	Bouts
6/6	68·6	74·5	65·5
6/9 and 6/12	16·5	13·6	14·5
6/18	10·0	6·8	14·5
Rest	4·9	5·0	5·5

$C = \cdot 10$

$\eta = \cdot 05$

Mother

Daughters	Sober	Drinks	Bouts
6/6	64·9	67·1	61·5
6/9 and 6/12	20·9	19·8	17·9
6/18	10·8	7·8	7·7
Rest	3·4	5·3	12·8

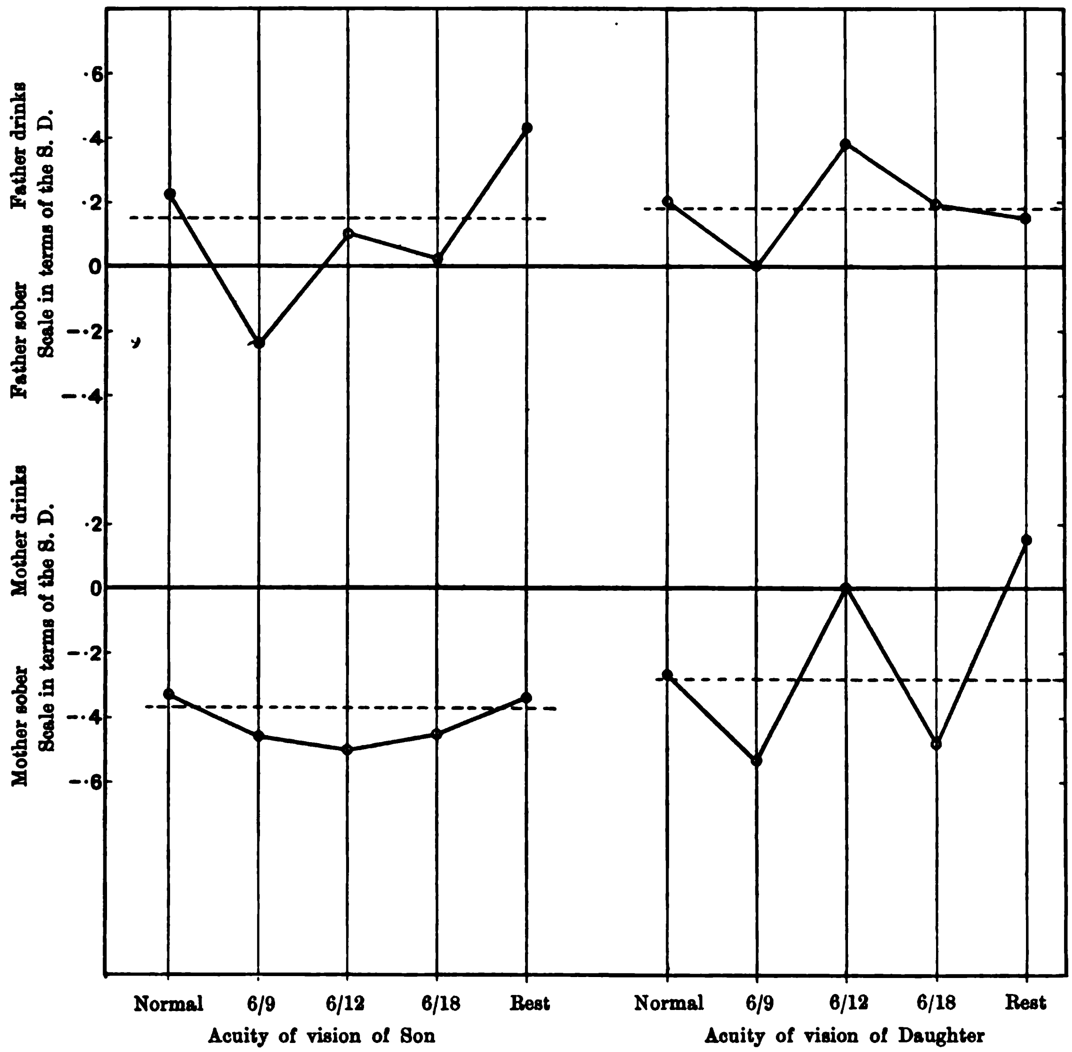
$C = \cdot 14$

$\eta = \cdot 11$

The difficulty is again the small number of cases of the most defective vision class, including vision measured from 6/24 etc.; there are only 25 to 30 cases and percentages

or means worked on so small a number may be very misleading. As in the case of refraction we find from these tables a larger percentage of normal eyesight among the children of intemperate parents (leaving bout drinkers out of the question) than among the children of temperate, and we find a larger amount of eyesight of 6/9 and 6/12 among the children of temperate parents. When we consider the worst kinds of eyesight the results are most irregular. In three out of four tables we get a larger proportion

FIG. 5. PARENTAL ALCOHOLISM AND ACUITY OF VISION OF CHILDREN (EDINBURGH).



of eyesight of 6/18 among the children of sober parents and in two out of four tables we get a larger proportion of the most defective eyesight also among the children of sober parents. It is quite obvious that if we divided the eyes into normal and defective we should have a negative correlation, and as in the case of refraction the association would be between the drinking parent and normal acuity of vision. The values found by η are given below those found by contingency and agree fairly well with them. If we examine the graphs of the means above we see great irregularity—this

is doubtless owing in part to the small number of cases of some types of vision—6/12 and what we have called the "rest" being based on from 25 to 40 cases only.

There is a similarity between these curves in some respects; we find that in all four the normal eyesight is above the mean, i.e. is getting into the "drinking" class of parents, and that eyesight measured by 6/9 in all four cases dips down into the sober class of parents; except in the case of mother and son eyesight of 6/12 is getting back into the drinking class and 6/18 dips again into the sober. In father and daughter the worst type of vision is found to be still further in the sober class, but for father and son and mother and daughter the worst type of vision is found comparatively high up among drinking parents. It is extremely difficult to say that there is any general slope of the means; and there is no definite conclusion which can be legitimately drawn beyond the assertion that if acuity of vision is related to parental alcoholism, the relation must be very slight and complex in character. If we simply divide the eyes into the two classes normal and abnormal the correlations if they are to be considered significant at all are negative, or again drinking in the parents is associated with normal vision in the offspring.

(8) *Parental Alcoholism and Eye Disease.* Diseases of the eye and eyelid were relatively few in number and no division of them into categories was statistically possible. The original tables are given as XLI to XLIV in the Appendix. Cases of strabismus presented a difficulty as these are very few, but we decided to keep them separate and work out the table as a ninefold contingency.

Father

Son	Sober	Drinks	Bouts
Normal ...	89·2	91·0	92·8
Diseased ...	6·9	5·9	5·4
Squint	3·8	3·2	1·8

$C = \cdot 07$

Father

Daughter	Sober	Drinks	Bouts
	86·2	88·0	86·8
	11·0	7·8	9·9
	2·9	4·2	3·3

$C = \cdot 08$

Mother

Son	Sober	Drinks	Bouts
Normal ...	90·7	89·7	89·5
Diseased ...	5·8	6·7	7·0
Squint	3·5	3·6	3·5

$C = \cdot 03$

Mother

Daughter	Sober	Drinks	Bouts
	87·5	86·0	94·7
	9·7	9·9	5·3
	2·8	4·1	—

$C = \cdot 10$

Drinking of the father and non-drinking of the mother are associated with normal eyes in son and daughter, and if we omit squint we shall find that the correlation between drink and eye disease is negative for the fathers and positive for the mothers. This difference may be just that due to the neglect that arises from the

existence of an alcoholic mother. But the values are very small and we think we may say that no correlation between intemperance of the parent and eye disease in the child is indicated by these data.

(9) *Influence of Home and Street Environment.* Throughout the above eye tables there is on the whole a larger percentage of normal eyes among the children of drinking parents than among the children of sober parents. The same thing was found by Barrington and Pearson when eyesight was correlated with overcrowding, bad economic condition of the home, and bad moral condition of the parents. Bad environmental conditions were found to be *slightly* associated with normal vision. "Can it be" they asked "that these bad home conditions keep the children in the streets, and so relatively away from the bad environment and in relatively fresher air*?" This same question may be asked in the case of drinking parents. Miss Barrows has investigated this point. She found (1) the correlation between the drinking of the parents and how the child spends its spare time, and (2) the correlation between the child's vision and where it spends its spare time. In the first case "where the child spends its spare time" was divided into five groups for the boys and four for the girls; the groups for the boys were (1) "house," (2) partly house, (3) house and outdoor employment or occupation, (4) partly streets, (5) streets. "Partly house" includes children who spend most of their spare time in the house and "partly street" those who spend most of their time in the streets. For the girls there was no group (3) as practically none had an "outdoor" employment. The percentages are given below. The original tables are XLV to XLVIII inclusive in the Appendix.

Where Son spends his spare time	Father: Sober	Father: Drinks	Father: Bouts	Son — Mother: Sober	Mother: Drinks	Mother: Bouts
House	46·2	34·2	29·9	44·4	28·9	27·3
Part house	14·3	8·1	8·5	12·9	9·6	9·1
House and outdoor occupation	12·5	8·1	12·8	13·4	6·6	7·6
Part street	11·5	12·6	12·0	11·2	12·0	16·7
Street	15·4	36·9	36·7	18·1	42·8	39·4

Father: $C = \cdot25$ Mother: $C = \cdot27$

Where Daughter spends spare time	Father: Sober	Father: Drinks	Father: Bouts	Daughter — Mother: Sober	Mother: Drinks	Mother: Bouts
House	56·6	47·8	44·0	57·3	43·9	41·9
Part house	15·3	9·4	16·5	14·0	12·8	16·3
Part street	11·1	18·2	16·5	15·5	13·3	16·3
Street	17·0	24·6	23·1	13·2	30·0	25·6

Father: $C = \cdot16$ Mother: $C = \cdot20$

* "Inheritance of Vision and of the Relative Influence of Heredity and Environment on Sight." By A. Barrington and K. Pearson, p. 55.

FIG. 6. ACUITY OF VISION AND WHERE CHILD SPENDS ITS SPARE TIME (EDINBURGH).

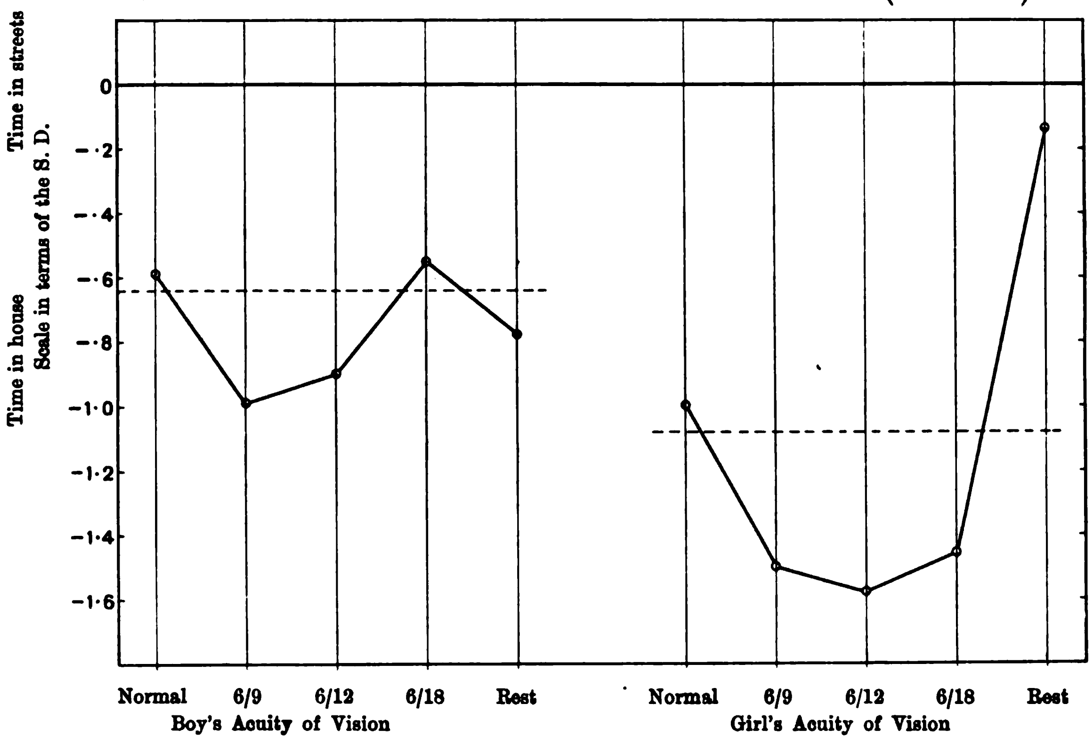
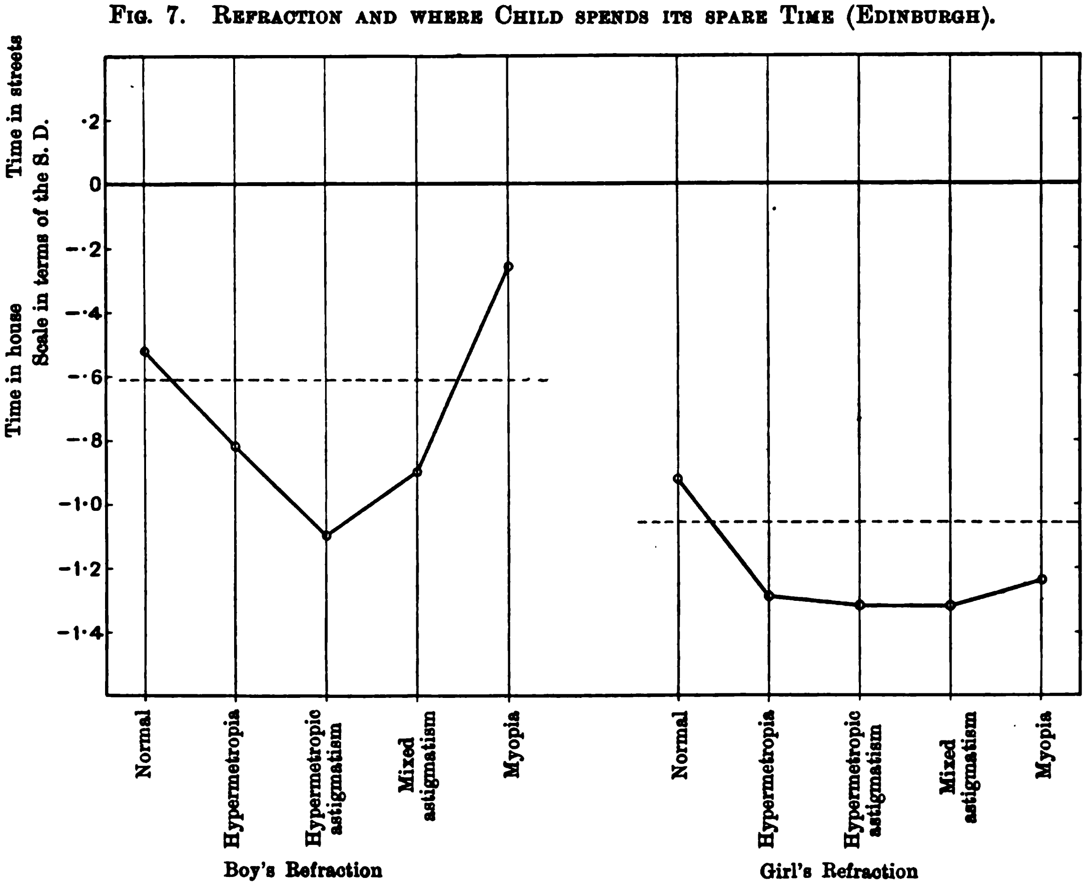


FIG. 7. REFRACTION AND WHERE CHILD SPENDS ITS SPARE TIME (EDINBURGH).



From these percentages it is clear that there is a quite considerable connection between the drinking of the parents and the fact that the child spends its time in the streets. Alcoholic parents drive the child out of doors. The correlations show that the mother's drink is more likely to drive the child into the streets than the father's drink and that boys are more affected than girls.

We must next examine the results which Miss Barrows found between the eyesight of the child and where it spent its time (Tables XLIX to LII in Appendix).

Acuity of Vision	Where Boy's spare time spent: House	Part house and part streets	Streets	Where Girl's spare time spent: House	Part house and part streets	Streets
Normal	72·2	67·4	76·3	67·1	57·8	73·3
6/9 and 6/12	14·7	18·8	9·5	18·2	30·1	9·3
Rest	13·1	13·8	14·2	14·7	12·1	17·3

Boys: $C = \cdot 16$; House and part streets $\eta = \cdot 14$; Streets and part streets $\eta = \cdot 07$

Girls: $C = \cdot 25$; $\eta = \cdot 29$; $\eta = \cdot 13$

Refraction	Where Boy's spare time spent: House	Part house and part streets	Streets	Where Girl's spare time spent: House	Part house and part streets	Streets
Normal	65·6	59·2	74·6	63·1	47·4	73·3
Hypermetropia	16·4	18·8	12·4	13·3	22·5	10·7
Hypermetropic astigmatism	11·6	15·1	5·6	15·4	16·2	9·3
Mixed astigmatism	3·9	3·9	2·4	5·2	6·1	3·3
Myopia and myopic astigmatism	2·5	3·0	5 0	3·0	7·8	3·3

Boys: $C = \cdot 22$; House and part streets $\eta = \cdot 21$; Streets and part streets $\eta = \cdot 05$

Girls: $C = \cdot 22$; $\eta = \cdot 19$; $\eta = \cdot 15$

An examination of the normals in these tables reveals a curious fact. In every case the largest percentage of normal eyes is found among children who are in the streets and the smallest percentage among children who are partly in the streets and partly in the house, while those children who are kept entirely in the house come half way between. This is not at all what we should expect; if being in the streets has a good influence on children's eyes, those children who are, at any rate, partly in the streets should have better eyes than those children who are kept entirely in the house, but we find nothing of the kind. The result of this curious fact is that if we divide our tables twice over and work out η we find that if we group "house" and "part house and part streets" together we get a sensible correlation, but if we group streets and "part house and part streets" together we get practically half the correlation for the girls and boys in the acuity of vision tables and a very small one for the boys in the refraction table because we are combining the highest and

lowest percentage in each case and this gives a value very close to the middle percentage which belongs to the "house only" group.

When we look at "acuity of vision" measured by 6/9 and 6/12 we see for boys and girls the largest percentage with this type of vision in the "part streets" group, the smallest percentage in the streets, while the percentage in the house lies between the other two. We get the largest percentage of the worst type of vision in the streets and the smallest percentage in the house among the boys, and in the "part streets" group among the girls.

Of hypermetropia and hypermetropic astigmatism we find the largest percentage in the "part streets" group and the smallest in the streets; while in the last two kinds of eyesight, mixed astigmatism and myopia, there seems to be a slight excess of myopia in the streets over children in the house and it is the other way round with mixed astigmatism. The curves for refraction and vision are interesting, showing a distinct difference of myopia between girls and boys. The boys with the worst vision are found indoors, the girls with the worst vision in the streets; the boys with the most myopia in the streets, and the girls with the most myopia indoors! Thus while the normal vision and normal refraction children are mostly in the streets, the worst vision girls and the myopic boys also frequent the streets. To test whether the "street" children were the older children, and therefore the more myopic, the average ages of the house and street boys and girls were calculated. The average age of the boys who spent their spare time in the streets was found to be 9·9 years, and in the house 9·2 years. The corresponding ages for the girls were 9·4 and 9·3 respectively. The six months difference in the case of the boys' ages may possibly account for some, but not for all the difference in myopia. Possibly also some of the boys prefer street to home for their spare time because they are myopic.

It must at once be confessed that the relationships whatever they may be between street and home and eyesight are too slight and too entangled for any definite conclusions to be drawn from the present statistics. Drunkenness of parents does send the children into the streets; the children of the alcoholic parents have somewhat the best eyesight, and the children with the more normal vision and better refraction are most in the streets. But when we begin to think how we may explain the better sight of the children of parents who drink we are at once met, in this matter, by innumerable difficulties; the myopic boys are also more in the streets; the boys and girls who are partly in the streets have in all cases less normal sight than those wholly in the streets; they have also more myopia than those kept wholly in the house. Thus our correlations, which seemed to denote some significance of relationship between time in the streets and sight, are found to be the result of more than random variations, but variations of which we can give no obvious and unique explanation. Bad home environment sends the children into the streets, this is demonstrated; but greater time in the streets is not associated continuously and uniquely with better vision and refraction.

(10) *Parental Alcoholism and the Child Death Rate.* In the C.O.S. Edinburgh Report the number of dead children is given for each family but the age at death is

not given so the mortality must be considered as a general child mortality and it may even include some young adults. In each family there is one child of school age so that the upper age limit cannot be very high.

In considering the mortality of these families we must also consider the total number of children born, as the mortality will naturally vary greatly with the size of the family. To find the connection between the drinking of the parents and the child mortality we must find the partial correlation coefficient and correct our "crude" mortality for a constant size of family; this means that we must find three correlation coefficients (1) between drinking of parents and gross mortality, (2) between drinking of parents and size of family, (3) between gross mortality and size of family.

We kept the three earlier divisions of sober, drinks and drinks in bouts and found the correlation rates. The first step in the process is to find the mean for each group, that is to say (1) the mean number of dead children, and (2) the mean size of family when the parents are sober, when they drink and when they drink in bouts (Appendix Tables LIII to LVI inclusive and Table LXII).

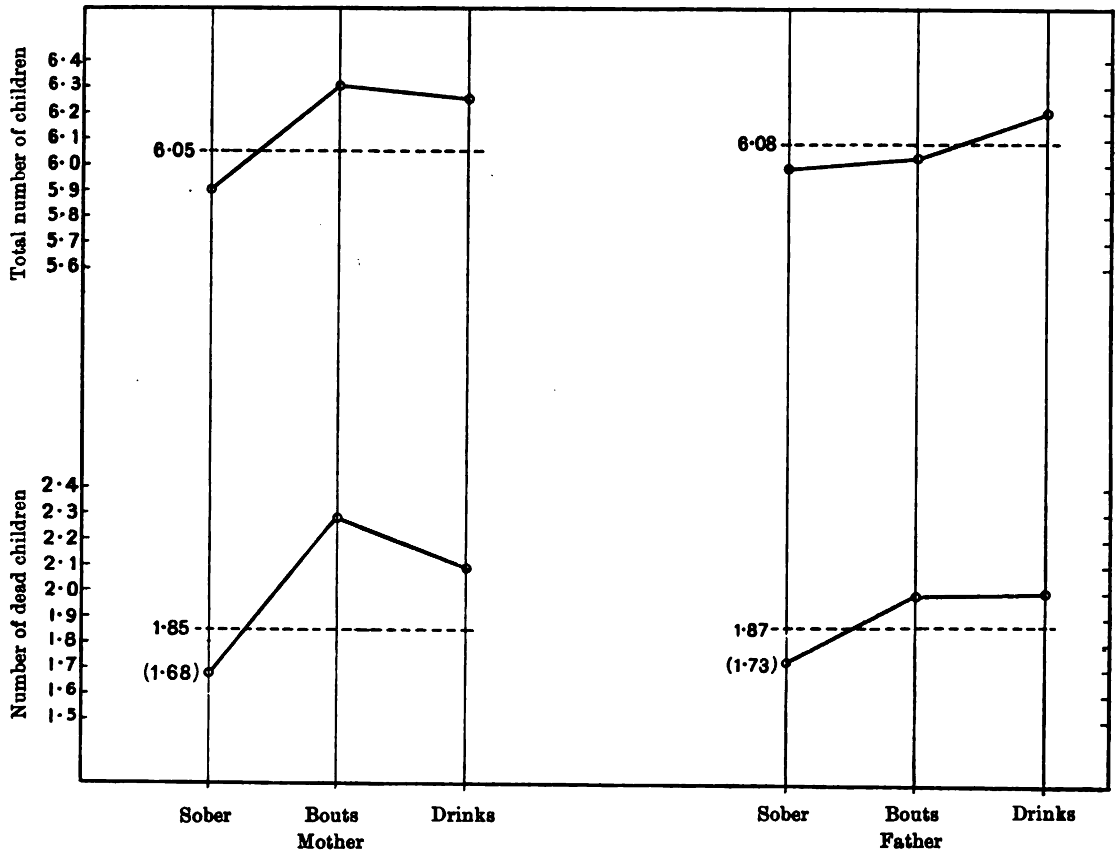
	Father			Mother		
	Sober	Drinks	Bouts	Sober	Drinks	Bouts
Average number of dead children	1·73	1·99	1·97	1·68	2·09	2·28
Average size of family	5·99	6·20	6·03	5·91	6·25	6·32
Nett family	4·26	4·21	4·06	4·23	4·16	4·04
Death rates, °/₀	28·9	32·1	32·7	28·4	33·4	36·1

These means show that sober fathers have on the average fewer dead children and smaller families than drinking fathers, and the same is true of sober mothers. These families are incomplete; whether completed families would show this difference or whether it is due to the older average age of drinking parents we cannot say; the age of the parents is not given in a sufficient number of cases to enable us to answer the question. The correlation between the father's drinking and the number of dead children is ·06 and between his drinking and the size of his family is ·04; the correlation between the number of dead children and the average size of a family in Edinburgh is ·72 and the correlation coefficient between drinking of the fathers and a child death rate for a constant size of family is $\cdot 046 \pm \cdot 027$. The correlation is very small but is positive, and as far as any stress can be laid on a correlation of ·05 it signifies that the child death rate is slightly heavier when the father drinks.

When we examine the means for the mother we see that when the mother drinks the death rate is heavier and that the differences are greater, but the most noticeable difference is when the mother drinks in "bouts"; the curves on p. 27 show this very clearly. In the case of the father the death rate is almost steady between the drinking and bout drinking fathers, but in the case of the mothers there is an excess of deaths when the mother drinks in bouts. We should be inclined to attribute this excess to

misadventure. The cause of death is not given in the C.O.S. report but one would expect accidents to occur more frequently when the mother has drunken bouts—overlaying probably accounts for some of the loss of infant life. Without knowing the cause of death we cannot say that death by accident is more common among the babies of mothers who drink in bouts, but it seems to us a reasonable supposition: this marked difference does not occur between drinkers and bout-drinkers among the fathers who would have less to do with the management and handling of the babies.

FIG. 8. PARENTAL ALCOHOLISM AND CHILD MORTALITY RATE (EDINBURGH).



The correlation between the mother's drinking and the child death rate is ·12 and between the mother's drinking and the size of family is ·07, and the partial correlation coefficient between the mother's drinking and the child death rate for a constant size of family is ·11. A correlation of ·11 is definitely significant and we can say that the drinking of the mother is associated with a higher child mortality. Some of this excess of child deaths is certainly due to accident, to overlaying, to burns, and to other causes arising from carelessness, but we should be inclined to attribute it, at least in part, to the same causes, probably to want of home care, to food defects, perhaps, to other factors possibly toxic, which also show themselves in slightly less height and weight among the children of the drinking mothers when these children reach a school age.

We will now examine the child death rate in the families of the mentally defective

in Manchester (Tables LVII to LXI in the Appendix). It must be remembered that this is a highly selected population. In this case the parents are only divided into temperate and intemperate, and the number of intemperates among the mothers is small, only 64 out of a total of 453 mothers, about whom a definite statement is made, being called intemperate. Either Manchester mothers are more temperate than Edinburgh mothers, which is possible, or temperate mothers are more numerous among the mothers of defective children or, in considering the mothers of Manchester children, only those mothers who are *very* intemperate have been included. It must be remembered therefore that our results are based on only 64 cases of intemperate mothers.

	Father		Mother	
	Sober	Drinks	Sober	Drinks
Average number of dead children	1·48	2·25	1·55	2·14
Average size of family...............	5·70	6·71	5·84	6·34
Nett family	4·32	4·46	4·29	4·20
Death rates, °/ₒ........................	25·8	33·5	26·5	33·8

The means show, as we found in Edinburgh, that the number of dead children is greater when the father or mother drinks and that the size of family is also greater. The correlation coefficient* between the father's drink and child death rate in Manchester is ·23, between the father's drink and size of family is ·19 and between the child death rate and size of family is ·75, and the partial correlation between the father's drink and child death rate for a constant size of family is ·13 ± ·03. This is a distinctly higher value than we found in Edinburgh.

The correlation coefficient between the mother's drinking and the number of dead children was ·17, between the mother's drinking and the size of family ·09, and the correlation between the drinking of the mother and the child death rate for a constant size of family was found to be ·15 ± ·03. These coefficients of ·13 and ·15 are large in comparison with most of the coefficients with which we have been dealing but come low in any general scale of correlations. They are certainly significant and show a connection between the drinking of the parents and a higher child mortality, which is slightly greater when the mother drinks than when the father drinks.

It is of interest to note how very little difference there is between the nett family of alcoholic and sober parents, and between the nett Manchester and Edinburgh families. Taking the difference in mortality rate of children of sober and alcoholic parents for Manchester we find that 11 °/ₒ of children who die, die under the increased death rate in the children of alcoholic over sober fathers and 5 °/ₒ under the increased death rate in the children of alcoholic over sober mothers†. The correlation between

* For method of working see *Biometrika*, Vol. VII. pp. 96 et sqq.

† The alcoholism of the mother produces more effect than that of the father, but the number of alcoholic mothers is far fewer. Hence the smallness of the 5 °/ₒ as compared with the 11 °/ₒ.

alcoholism in husband and wife is large, roughly about ·7, hence these percentages are not independent. We shall err in excess if we put the total increased death rate at 13 °/$_0$ *among the stocks which produce the feeble-minded in Manchester.*

Among the Edinburgh sample of the general population the corresponding numbers are 7·7 °/$_0$ and 5·5 °/$_0$, the lesser alcoholism of the mothers in this case producing a relatively greater effect. The total increased death rate can thus hardly exceed 10 °/$_0$. The results for Edinburgh and Manchester seem to indicate that from the general population to a special degenerate class—the parents of feeble-minded children—the excess death rate due to alcohol ranges from 10 °/$_0$ to 13 °/$_0$ of the deaths. These results seem hardly in keeping with a current statement that 25 °/$_0$ of the deaths of children below the age of five years are due to intemperance. The percentage is large enough without any exaggeration. But it is no paradox to assert that if the alcoholists became sober the nett gain in child life would not even be 10 °/$_0$ to 13 °/$_0$ but scarcely 1 °/$_0$, because the alcoholic parents are more fertile than the sober, and so their nett families are almost the same. Those who assert that the increase of the population would be 25 °/$_0$ more rapid but for alcoholism have overlooked the question of the *nett* fertility of alcoholic parents.

Summary of Conclusions. When characters are closely related, or their correlations high, then it is well known that the probable errors of these relationships will be small, and even when we deal with moderate samples the relationships will stand out significantly and without confusion. All work hitherto undertaken in the Galton Eugenics Laboratory to measure the relationship between home environment and characters in children has shown low correlations, values in fact lying between ·0 and ·2 numerically. Such slight values, especially on the relatively small samples at present available, must lead to doubt and obscurity; the variations due to random sampling are of the same order as the quantitative relations we wish to disentangle. There may be some association between environment and human characters, but its order if measured by such correlations is so slight that it cannot be effectively dealt with on the basis of the samples available. This has been the case with Barrington and Pearson's investigations on the influence of home environment on sight, with Heron's work as to unfavourable home conditions and intelligence, with Elderton's inquiry into the influence of parental occupation on the intelligence and physique of offspring. It has been the case also with a number of subsidiary inquiries undertaken in the Laboratory on similar points. We seem forced to admit either that for the types of environment dealt with this influence is very small, or that the data are completely untrustworthy. Yet the several sets of data which independently lead to these conclusions have been collected at a number of different centres, London, Manchester, Glasgow, Aberdeen, Edinburgh, and by quite different systems and with different observers. In every case the inquiry has been carried out by trained social workers, and the medical observations have been planned and recorded by medical men of special knowledge and enthusiasm for their task. Difficulties of reduction and interpretation there have been and must always be. But, if we are to consider these inquiries and records of no service, then while it may be possible now on the basis of

this experience to organise more complete and in some respects more efficient surveys, it is really hopeless to suppose that new surveys will so surpass the old in accuracy, that we shall get not only substantially better, but wholly diverse results from their analysis. It seems more reasonable to believe that our difficulty lies elsewhere, that in seeking to measure environmental influence, we are not failing to find a large factor in human development owing to the carelessness of our record, but rather that we are failing to discover it, because it needs a statistical microscope for its examination. It is not a large but a small factor, and therefore requires larger samples than are at present available to measure its effects clearly and definitely. Our work in the Laboratory does not demonstrate that there is no environmental influence, but only that it is too small to be safely disentangled from the limited observations at present recorded. This appears to us to be the reasonable attitude to take. If the critic replies that our phases of the environment factor registered in other ways would indicate large environmental effects, we think we are justified in suggesting that the onus of collecting the material and reducing it now lies upon him. It must be remembered that observations of much the same nature as we have been dealing with do show high correlations, when we investigate hereditary influence. We are not able therefore to say that low correlations due to haphazard observation are essential to such surveys. Judged by practically the same or the same type of inquiry the hereditary factor appears on the average 4 to 10 times as potent as the environmental factor.

There is another point also which appears of much moment. The records with which we have dealt were not made by collectors pledged to any programme of reform. There is no evidence that they were in the least intended to illustrate the points of inquiry we have had in view. No one can believe that Miss Dendy and Dr Ashby made a record of the families of the Manchester mentally defectives with the bias that parental alcoholism would have no effect on the intelligence and health of the offspring; no one will suspect Dr Kerr and the officers and teachers of the London Educational Committee of collecting data with the *a priori* view of demonstrating that nutrition and cleanliness had small influence on the mental capacity of the children committed to their charge; none will suppose that the Glasgow Education Committee made up their minds to design a survey which should demonstrate that occupations of father and mother had small effect on the welfare of their offspring; nor can it be suggested that the Edinburgh Charity Organisation Committee with their trained group of workers and medical adviser Dr Leslie Mackenzie started to show that bad home conditions and alcoholic parents were matters of small moment to the physical and mental condition of the children. Rather in one and all these cases (if the critic does not, as we should, give credit for the existence of a single-minded desire to discover the truth) there would probably be an ingrained philanthropic conception, that the removal of so much misery would lead to most marked improvement in the physique and intelligence of the children, as it would undoubtedly lead to their increased immediate happiness. Nay, there may be some of our readers who know sufficiently intimately the spirit of the Galton Laboratory workers, to give them also credit for having approached this problem of environment with no prejudice in favour of the results

ultimately reached, but rather with a belief that they were about to determine those features of environment, which were the chief sources of physical and mental deficiency in the child.

It may surprise those readers who are not of this class to learn that even after much work had been done in this field, there was still a reasonable anticipation that alcoholism in the parent would be found to have not only, through the direct and cross factors of heredity, a marked influence on the child but toxic and environmental effects of possibly an even graver kind. A strong personal feeling with regard to the slightest alcoholic excess rapidly leads to a bias in favour of attributing to it all the ills of society, and it would have been difficult for us to have claimed entire freedom from this bias when we first approached this subject. Here at least we anticipated that marked environmental effects would be found and quantitatively defined. The result of a first study is embodied in the present paper. What has resulted may be summed up as follows:

(1) There is a higher death rate among the offspring of alcoholic than among the offspring of sober parents. This appears to be more marked in the case of the mother than in the case of the father, and since it is sensibly higher in the case of the mother who has drinking bouts than of the mother who habitually drinks, it would appear to be due very considerably to accidents and gross carelessness and possibly in a minor degree to a toxic effect on the offspring.

Owing to the greater fertility of alcoholic parents, the nett family of the sober is hardly larger than the nett family of the alcoholic.

(2) The mean weight and height of the children of alcoholic parents are slightly greater than those of sober parents, but as the age of the former children is slightly greater, the correlations when corrected for age are slightly positive, i.e. there is slightly greater height and weight in the children of the sober. In the case of the father the correlations are not significant having regard to their probable error; in the case of the mother they may be just significant but they are so slight as to have no importance*.

(3) The wages of the alcoholic as contrasted with those of the sober parent show a slight difference compatible with the employers' dislike for an alcoholic employee, but wholly inconsistent with a marked mental or physical inferiority in the alcoholic parent.

(4) The general health of the children of alcoholic parents appears on the whole slightly better than the health of the children of sober parents. There are fewer delicate children and in a most marked way cases of tuberculosis and epilepsy are less frequent than among the children of sober parents. The source of this relation may be sought in two directions; the physically strongest in the community have probably the greatest capacity and taste for alcohol. Further the higher death rate of the children of alcoholic parents probably leaves the fitter to survive†. Epilepsy and

* These differences even may well be due to a racial differentiation, e.g. to a sprinkling of Irish, or short Celts, among the extreme drinkers.

† Sir Victor Horsley has asserted that the higher death rate,—not a small part of which is also an accident rate—is incompatible with slightly better health in the surviving children. We see no *a priori* basis for such a dogma; it can only be statistically justified.

tuberculosis both depending upon inherited constitutional conditions. they will be more common in the parents of affected offspring, and, probably if combined with alcohol, are incompatible with any length of life or much size of family. If these views be correct, we can only say that parental alcoholism has no marked effect on filial health.

(5) Parental alcoholism is not the source of mental defect in offspring.

(6) The relationship, if any, between parental alcoholism and filial intelligence is so slight, that even its sign cannot be determined from the present material.

(7) The normal visioned and normal refractioned offspring appear to be in rather a preponderance in the families of the drinking parents, the parents who have "bouts" give intermediate results, but there is no substantial relationship between goodness of sight and parental alcoholism. Some explanation was sought on the basis of alcoholic homes driving the children out into the streets. This was found to be markedly the case, the children of alcoholic parents spending much more of their spare time in the street. An examination, however, of the vision and refraction of children with regard to the time they spent in- or out-doors, showed no clear and definite result. The children who spent the whole or most of their spare time in the streets having most myopia and also most normal sight. It was not possible to assert that the outdoor life was better for the sight, or that the better sight of the offspring of alcoholic parentage was due to the greater time spent outdoors.

(8) The frequency of diseases of the eye and eyelids, which might well be attributed to parental neglect, was found to have little, if any, relation to parental alcoholism.

To sum up then, no *marked* relation has been found between the intelligence, physique or disease of the offspring and parental alcoholism in any of the categories investigated. On the whole the balance turns as often in favour of the alcoholic as of the non-alcoholic parentage. It is needless to say that we do not attribute this to the alcohol but to certain physical and possibly mental characters which appear to be associated with the tendency to alcohol. Other categories when investigated may give a different result, but we confess that our experience as to the influence of environment has now been so considerable, that we hardly believe large correlations are likely to occur.

If, as we think, the danger of alcoholic parentage lies chiefly in the direct and cross-hereditary factors of which it is the outward or somatic mark, the problem of those who are fighting alcoholism is one with the fundamental problem of eugenics. We fear it will be long before the temperance reformer takes this to heart. He is fighting a great and in many respects a good fight, and in war all is held fair, even to a show of unjustifiable statistics. Yet the time is approaching when real knowledge must take the place of energetic but untrained philanthropy in dictating the lines of feasible social reform. We can only hope that this intrusion into the field of alcoholic inquiry will be recognised as an earnest attempt to measure the true influences of a grave social evil. Yet we have our fears, for as Plato in the *Euthyphro* reports Socrates to have said: *'Αθηναίοις γάρ τοι, ὡς ἐμοὶ δοκεῖ, οὐ σφόδρα μέλει, ἄν τινα δεινὸν οἴωνται εἶναι, μὴ μέντοι διδασκαλικὸν τῆς αὑτοῦ σοφίας· ὃν δ' ἂν καὶ ἄλλους οἴωνται ποιεῖν τοιούτους, θυμοῦνται, εἴτ' οὖν φθόνῳ, ὡς σὺ λέγεις, εἴτε δι' ἄλλο τι.*

APPENDIX. TABLES OF DATA.

Table I. *Height of Sons when the Father only is Alcoholic (Edinburgh).*

Age of sons

Height of sons in inches	5	6	7	8	9	10	11	12	13	14	Totals
31					1						1
33											
35											
37	1	1									2
39	4	3	1	2							10
41	2	1	7	1	1	1		1			14
43		1	4	3	3	1					12
45		2	9	6	2·5	1·5					21
47			2	5	3	6					16
49				2	5	4	8	1	3		23
51				1	1	7	7	5	2		23
53					1		4	5	1		11
55							1	3	2		6
57								1	1	1	3
59											
61								1			1
Totals	7	8	23	20	17·5	20·5	20	17	9	1	143

Table II. *Height of Sons when the Mother only is Alcoholic (Edinburgh).*

Age of sons

Height of sons in inches	5	6	7	8	9	10	11	12	13	14	Totals
31											
33											
35		1									1
37				1							1
39		2									2
41	1		3	1	1						6
43		2	1								3
45	1		1								2
47					2	1					3
49				1	1		1				3
51					1	1	1				3
53						1	1	2	2		6
55						1					1
57									1		1
59											
61											
Totals	2	5	5	3	5	4	3	2	3		32

Table III. *Height of Sons when both the Parents are Alcoholic (Edinburgh).*

Age of sons

Height of sons in inches	5	6	7	8	9	10	11	12	13	14	Totals
31											
33											
35	2										2
37	2										2
39	3	2		1							6
41		2	3	2	2			1			10
43	1	4	5	2	2		1				15
45		3	3	9	9	2	1				27
47			1	1	6	5	3	2			18
49			1	1	5	5	6	5	1		24
51					·5	4·5	8	7	3		23
53					1			1	2	1	5
55								2	2	1	5
57								1	2		3
59											
61											
Totals	8	11	13	16	25·5	16·5	19	19	10	2	140

Table IV. *Height of Sons when neither Parent is Alcoholic (Edinburgh).*

Age of sons

Height of sons in inches	4	5	6	7	8	9	10	11	12	13	14	Totals
31												
33												
35												
37		3		1		1						5
39	1	4	5	3								13
41		7	16	5	4			1				33
43		3	12	8	11	4	2					40
45		1	6	6	13	11	4	3				44
47			1		10	11	10	3	2			37
49				1	1	6	10	6	4	2		30
51					1	4	5	10	4	6		30
53						2	1	5	8	3		19
55						2		2	3	8		15
57									2	1	1	4
59												
61												
Totals	1	18	40	24	40	41	32	30	23	20	1	270

TABLE V. *Weight of Sons when the Father only is Alcoholic (Edinburgh).*

Age of sons

Weight of sons in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
28		1									1
32	2		2								4
36	3	3	2	2							10
40	2	1	2	3	2	1					11
44		1	7	2	2·5	1·5					14
48		1	8	4	1	2			1		17
52		1	2	2	5	3					13
56				4		3	3	2			12
60				2	3	7	5	2	1		20
64				1	4	3	4	3	1		16
68							6	5	3		14
72							2	1	1		4
76								2			2
80								1	1	1	3
84											
88											
92								1	1		2
Totals	7	8	23	20	17·5	20·5	20	17	9	1	143

TABLE VI. *Weight of Sons when the Mother only is Alcoholic (Edinburgh).*

Age of sons

Weight of sons in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
28		1									1
32	1	1									2
36				1							1
40	1	1	3		1						6
44		2	1	1							4
48			1			1					2
52					1						1
56				1	2		1				4
60											
64					1	1	1		1		4
68						1	1				2
72						1		2	1		4
76											
80											
84											
88									1		1
92											
Totals	2	5	5	·3	5	4	3	2	3		32

TABLE VII. *Weight of Sons when both the Parents are Alcoholic (Edinburgh).*

Age of sons

Weight of sons in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
28	1										1
32	4										4
36	2	2	1	1							6
40		2	4	2	3			1			12
44	1	3	4	6	5	1	1				21
48		4	2	5	7	1	2				21
52			1		2	1	1				5
56				2	4·5	6·5	6	2			21
60					2	4	5	9			20
64			1		2	2	3	3	2		13
68						1	1	2	2		6
72									5	2	7
76								1	1		2
80								1			1
84											
88											
92											
Totals	8	11	13	16	25·5	16·5	19	19	10	2	140

TABLE VIII. *Weight of Sons when neither Parent is Alcoholic (Edinburgh).*

Age of sons

Weight of sons in lbs.	4	5	6	7	8	9	10	11	12	13	14	Totals
28		2										2
32		3	3	3								9
36		6	5	3	1	1						16
40	1	4	12	4	2	2		1				26
44		3	14	10	16	6	1	1				51
48			4	2	6	9	4	1				26
52			2	2	9	6	11		2			32
56					3	8	7	8	1			27
60					3	2	4	7	2	2		20
64						2	3	2	4	4		15
68						4	1	5	5	6		21
72								3	6	4		13
76							1	1	2			4
80								1		1	1	3
84									1	2		3
88						1						1
92										1		1
Totals	1	18	40	24	40	41	32	30	23	20	1	270

TABLE IX. *Height of Daughters when the Father only is Alcoholic (Edinburgh).*

Age of daughters

Height of daughters in inches	5	6	7	8	9	10	11	12	13	14	Totals
28											
30	1										1
32											
34	1	1									2
36											
38	4	3									7
40	5	7	1						1		14
42	1	1	4	5	1						12
44		2	4	2	1						9
46		1	1	2	6	3	1				14
48				1	5	4	5				15
50			1		4	2	2	3	1		13
52						1	4	3	2		10
54								1	4		5
56							1		1		2
58									1		1
Totals	12	15	11	10	17	10	13	7	10		105

TABLE X. *Height of Daughters when the Mother only is Alcoholic (Edinburgh).*

Age of daughters

Height of daughters in inches	5	6	7	8	9	10	11	12	13	14	Totals
28											
30											
32											
34											
36	1	1									2
38	1	1									2
40	1	1		2							4
42			1	3	1						5
44		1	1		1						3
46			1	2	1	5					9
48							3	1			4
50							3				3
52					1		2	1			4
54							1		1		2
56									1		1
58									2		2
Totals	3	4	3	7	4	5	9	2	4		41

TABLE XI. *Height of Daughters when both the Parents are Alcoholic (Edinburgh).*

Age of daughters

Height of daughters in inches	5	6	7	8	9	10	11	12	13	14	Totals
28											
30											
32											
34											
36		2							1		3
38	4	2	3								9
40	2	9	6								17
42	2		8	2	3	1					16
44		2	3	2	4	1					12
46			1	5	8·5	4·5	1		1		21
48				1	3	2	7		1		14
50						5	5	3	5		18
52							2	4	1		7
54								1	2		3
56									1	1	2
58									2		2
60											
62											
Totals	8	15	21	10	18·5	13·5	15	8	14	1	124

TABLE XII. *Height of Daughters when neither Parent is Alcoholic (Edinburgh).*

Age of daughters

Height of daughters in inches	5	6	7	8	9	10	11	12	13	14	Totals
28			1	1							2
30					1						1
32											
34	1							1			2
36	3	2						1			6
38	4	4	1								9
40	4	11	5	1							21
42	2	6	13	3	2						26
44		2	5	9	6						22
46		2	3	11	7	2	4	1			30
48				3	8	9	6	2			28
50			1	1	4	5	3	6	1		21
52						5	7	5	1		18
54							3	6	5		14
56						1	1	1	1		4
58									2		2
60											
62									1		1
Totals	14	27	29	29	28	22	24	23	11		207

Table XIII. *Weight of Daughters when the Father only is Alcoholic (Edinburgh).*

Age of daughters

Weight of daughters in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
28	2	1									3
32	1	2									3
36	7	5	1								13
40	1	4	3	4	1						13
44	1	1	3	4	1	1	1				12
48		1	2		3	1	1				8
52			1	2	7	2	1				13
56		1	1		2	5	3	1			13
60					2		3	1	1		7
64							2	2	1		5
68					1		1	1	4		7
72									1		1
76							1		1		2
80						1			1		2
84								2	1		3
88											
92											
96											
100											
104											
108											
Totals	12	15	11	10	17	10	13	7	10		105

Table XIV. *Weight of Daughters when the Mother only is Alcoholic (Edinburgh).*

Age of daughters

Weight of daughters in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
28	1	1									2
32	1										1
36	1			1	1						3
40		1	2	2							5
44		1		2	1	2					6
48		1	1		1	1					4
52				2		1	1				4
56						1	3	1			5
60							2				2
64											
68					1		2				3
72							1	1	2		4
76											
80											
84											
88									1		1
92											
96											
100											
104											
108									1		1
Totals	3	4	3	7	4	5	9	2	4		41

Table XV. *Weight of Daughters when both the Parents are Alcoholic (Edinburgh).*

Age of daughters

Weight of daughters in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
24											
28		2									2
32	3	1	3								7
36	2	8	6		1						17
40	2	3	4	3	6						18
44	1	1	6	1	3	2					14
48			1	5	4·5	2·5	2		1		16
52					3	2	3				8
56			1	1			5	1	3		11
60					1	7	2	3	4		17
64							1	2	1		4
68							1	2			3
72							1				1
76										1	1
80									1		1
84									2		2
88											
92									1		1
96									1		1
Totals	8	15	21	10	18·5	13·5	15	8	14	1	124

Table XVI. *Weight of Daughters when neither Parent is Alcoholic (Edinburgh).*

Age of daughters

Weight of daughters in lbs.	5	6	7	8	9	10	11	12	13	14	Totals
24	1										1
28	3	3									6
32	5	3	1								9
36	2	6	6	1							15
40	2	9	11	5	3						30
44		4	6	3	6	1	2				22
48	1	2	4	12	2	2	3				26
52				5	11	4	1	3			24
56			1	2	4	4	4	3			18
60				1	2	6	4	3	2		18
64						1	6	4	1		12
68						2	1	1	3		7
72						1	2	5	2		10
76						1	1	3			5
80								1			1
84											
88											
92									2		2
96											
116									1		1
Totals	14	27	29	29	28	22	24	23	11		207

TABLE XVII. *Paternal Alcoholism & Health of Son (Manchester).*

Father

Health of son	Temperate	Intemperate	Totals
Healthy	346·5	126·5	473
Delicate	89·5	28·5	118
Phthisis	7	3	10
Epileptic......	30	5	35
Died young...	133	42	175
Totals	606	205	811

TABLE XVIII. *Paternal Alcoholism & Health of Daughter (Manchester).*

Father

Health of daughter	Temperate	Intemperate	Totals
Healthy	262	109	371
Delicate	67	29	96
Phthisis	4	3	7
Epileptic......	37	5	42
Died young...	83	38	121
Totals	453	184	637

TABLE XIX. *Maternal Alcoholism & Health of Son (Manchester).*

Mother

Health of son	Temperate	Intemperate	Totals
Healthy	306	55·5	361·5
Delicate	80	17·5	97·5
Phthisis	5	1	6
Epileptic......	23	1	24
Died young...	118	15	133
Totals	532	90	622

TABLE XX. *Maternal Alcoholism & Health of Daughter (Manchester).*

Mother

Health of daughter	Temperate	Intemperate	Totals
Healthy	239·5	38	277·5
Delicate	59·5	12	71·5
Phthisis	3	1	4
Epileptic......	31	1	32
Died young...	73	14	87
Totals	406	66	472

TABLE XXI. *Paternal Alcoholism & Health of Son (Edinburgh).*

Father

Health of son	Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Healthy...	4	51	4	50	24	133
Glands ...	2	68	1	64	44	179
Chest		10		17	8	35
Heart......	3	7	1	12	6	29
Other diseases		29		15	6	50
Totals ...	9	165	6	158	88	426

TABLE XXII. *Paternal Alcoholism & Health of Daughter (Edinburgh).*

Father

Health of daughter	Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Healthy...	2	52	6	46	21	127
Glands ...	8	65	10	64	36	183
Chest	2	13	3	14	8	40
Heart......		9		10	2	21
Other diseases		17		10	5	32
Totals ...	12	156	19	144	72	403

TABLE XXIII. *Maternal Alcoholism & Health of Son (Edinburgh).*

Mother

Health of son	Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Healthy...	4	82	4	35	12	137
Glands ...	2	103	6	55	26	192
Chest		23		11	4	38
Heart......	1	15	1	8	1	26
Other diseases	1	37	1	8	4	51
Totals ...	8	260	12	117	47	444

TABLE XXIV. *Maternal Alcoholism & Health of Daughter (Edinburgh).*

Mother

Health of daughter	Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Healthy...	1	73	7	48	7	136
Glands ...	8	103	7	64	18	200
Chest	2	33	1	11	4	51
Heart......		16	1	6	3	26
Other diseases	1	24		8	4	37
Totals ...	12	249	16	137	36	450

Table XXV. *Paternal Alcoholism & Intelligence of Son (Manchester).*

Father

Intelligence of son	Temperate	Intemperate	Totals
Normal	455	183	638
Mentally defective	319	95	414
Totals	774	278	1052

Table XXVI. *Paternal Alcoholism & Intelligence of Daughter (Manchester).*

Father

Intelligence of daughter	Temperate	Intemperate	Totals
Normal	472	191	663
Mentally defective	210	80	290
Totals	682	271	953

Table XXVII. *Maternal Alcoholism & Intelligence of Son (Manchester).*

Mother

Intelligence of son	Temperate	Intemperate	Totals
Normal	404	72	476
Mentally defective	260	48	308
Totals	664	120	784

Table XXVIII. *Maternal Alcoholism & Intelligence of Daughter (Manchester).*

Mother

Intelligence of daughter	Temperate	Intemperate	Totals
Normal	393	75	468
Mentally defective	169	24	193
Totals	562	99	661

Table XXIX. *Paternal Alcoholism & Intelligence of Son (Edinburgh).*

Father

Intelligence of son	Teeto-taller	Sober	Drink suspected	Drinks	Bouts	Totals
Excellent	2	19	3	9	11	44
Good	6	94	3	84	27	214
Medium	5	88	4	81	37	215
Dull	2	44	1	31	12	90
Defective		8		7	1	16
Totals	15	253	11	212	88	579

Table XXX. *Paternal Alcoholism & Intelligence of Daughter (Edinburgh).*

Father

Intelligence of daughter	Teeto-taller	Sober	Drink suspected	Drinks	Bouts	Totals
Excellent		13		13	3	29
Good	6	69	9	62	38	184
Medium	8	82	4	75	35	204
Dull	3	31	6	31	12	83
Defective		4	1	4	4	13
Totals	17	199	20	185	92	513

Table XXXI. *Maternal Alcoholism & Intelligence of Son (Edinburgh).*

Mother

Intelligence of son	Teeto-taller	Sober	Drink suspected	Drinks	Bouts	Totals
Excellent	1	27	1	11	3	43
Good	5	150	5	60	25	245
Medium	4	148	4	51	19	226
Dull	3	63	2	23	11	102
Defective	1	7	1	4		13
Totals	14	395	13	149	58	629

Table XXXII. *Maternal Alcoholism & Intelligence of Daughter (Edinburgh).*

Mother

Intelligence of daughter	Teeto-taller	Sober	Drink suspected	Drinks	Bouts	Totals
Excellent	1	16		10	3	30
Good	4	130	7	51	13	205
Medium	6	124	7	64	13	214
Dull	3	47	4	29	7	90
Defective		9		4	3	16
Totals	14	326	18	158	39	555

TABLE XXXIII. *Paternal Alcoholism & Refraction of Son (Edinburgh).*

Son's eyesight (Refraction)	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal	12	291	20	296	138	757
Hypermetropia	4	101	2	51	39	197
Hypermetropic astigmatism	5	58		31	23	117
Mixed astig-matism	3	19		16	7	45
Myopia		9		5	5	19
Myopic astig-matism	2	4		5	6	17
Totals	26	482	22	404	218	1152

TABLE XXXIV. *Paternal Alcoholism & Refraction of Daughter (Edinburgh).*

Daughter's eyesight (Refraction)	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal	8	226	22	209	105	570
Hypermetropia	10	62	8	54	29	163
Hypermetropic astigmatism	4	53	6	56	29	148
Mixed astig-matism	8	18	2	8	10	46
Myopia	3	9		3	4	19
Myopic astig-matism	1	8		6	5	20
Totals	34	376	38	336	182	966

TABLE XXXV. *Maternal Alcoholism & Refraction of Son (Edinburgh).*

Son's eyesight (Refraction)	Mother: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal	12	494	22	210	68	806
Hypermetropia	2	121		42	27	192
Hypermetropic astigmatism	8	81	6	34	11	140
Mixed astig-matism	2	31		4	5	42
Myopia		16		4	1	21
Myopic astig-matism	2	15			2	19
Totals	26	758	28	294	114	1220

TABLE XXXVI. *Maternal Alcoholism & Refraction of Daughter (Edinburgh).*

Daughter's eyesight (Refraction)	Mother: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal	8	371	22	194	47	642
Hypermetropia	6	103		46	5	160
Hypermetropic astigmatism	2	97	4	39	12	154
Mixed astig-matism	9	34	5	10	7	65
Myopia	2	10	1	1	4	18
Myopic astig-matism	1	9	2	6	1	19
Totals	28	624	34	296	76	1058

TABLE XXXVII. *Paternal Alcoholism & Acuity of Vision of Son (Edinburgh).*

Acuity of vision of son	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal...	6	162	10	155	74	407
6/9.........	3	38		17	11	69
6/12	1	10		8	5	24
6/18	3	23		14	13	53
6/24		1		5	2	8
Rest	1	6		5	4	16
Totals ...	14	240	10	204	109	577

TABLE XXXVIII. *Paternal Alcoholism & Acuity of Vision of Daughter (Edinburgh).*

Acuity of vision of daughter	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
Normal...	7	125	11	111	60	314
6/9.........	5	26	1	21	9	62
6/12	2	11	3	15	6	37
6/18	2	18	4	15	8	47
6/24		4		5	3	12
Rest	1	6		3	3	13
Totals...	17	190	19	170	89	485

TABLE XXXIX. *Maternal Alcoholism & Acuity of Vision of Son (Edinburgh).*

Acuity of vision of son	Mother: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal...	5	262	11	109	36	423
6/9.........	3	42	1	14	7	67
6/12		19	1	6	1	27
6/18	3	36	1	10	8	58
6/24	1	6		1	2	10
Rest	1	11		7	1	20
Totals...	13	376	14	147	55	605

TABLE XL. *Maternal Alcoholism & Acuity of Vision of Daughter (Edinburgh).*

Acuity of vision of daughter	Mother: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal...	7	204	12	100	24	347
6/9.........	5	44		18	3	70
6/12		19	2	13	4	38
6/18	1	34	1	12	3	51
6/24		3	1	5	2	11
Rest	1	7		3	3	14
Totals...	14	311	16	151	39	531

TABLE XLI. *Paternal Alcoholism & Son's Eye Disease (Edinburgh).*

Eye disease of son	Father: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal.........	12	220	11	190	103	536
Conjunctivitis		5		2	3	10
Corneal nebulae	1	7		5	1	14
Blepharitis ...		4		4	2	10
Others		1		2		3
Squint	1	9		7	2	19
Totals......	14	246	11	210	111	592

TABLE XLII. *Paternal Alcoholism & Daughter's Eye Disease (Edinburgh).*

Eye disease of daughter	Father: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal.........	14	167	17	152	79	429
Conjunctivitis		3	1	5	3	12
Corneal nebulae	2	5		6	3	16
Blepharitis		9		3	2	14
Others		4			1	5
Squint	1	5	1	7	3	17
Totals......	17	193	19	173	91	493

TABLE XLIII. *Maternal Alcoholism & Son's Eye Disease (Edinburgh).*

Eye disease of son	Mother: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal.........	12	348	12	136	51	559
Conjunctivitis		2	1	3	2	8
Corneal nebulae		12		4	1	17
Blepharitis ...		5	1	2	1	9
Others		4				4
Squint	1	13		6	2	22
Totals......	13	384	14	151	57	619

TABLE XLIV. *Maternal Alcoholism & Daughter's Eye Disease (Edinburgh).*

Eye disease of daughter	Mother: Teetotaller	Sober	Drink suspected	Drinks	Bouts	Totals
Normal.........	11	268	15	132	36	462
Conjunctivitis		6	2	4		12
Corneal nebulae	2	9		4	1	16
Blepharitis ...		12		5		17
Others		2	1	1	1	5
Squint	1	8		7		16
Totals......	14	305	18	153	38	528

TABLE XLV. *Paternal Alcoholism & where the Son spends his Spare Time (Edinburgh).*

Where son spends his time	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
House	10	119	9	67	35	240
Part house		40	1	17	10	68
House and out-door occupation		35		18	15	68
Part streets	3	29	2	26	14	74
Streets	2	41	3	79	43	168
Totals	15	264	15	207	117	618

TABLE XLVI. *Paternal Alcoholism & where the Daughter spends her Spare Time (Edinburgh).*

Where daughter spends her time	Father: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
House	11	122	17	80	40	270
Part house...		36	1	18	15	70
Part streets	6	20	3	34	15	78
Streets		40	1	49	21	111
Totals ...	17	218	22	181	91	529

TABLE XLVII. *Maternal Alcoholism & where the Son spends his Spare Time (Edinburgh).*

Where son spends his time	Mother: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
House	8	171	9	39	18	245
Part house	1	51	4	12	6	74
House and out-door occupation		54		11	5	70
Part streets	3	42	1	19	11	76
Streets	3	70	3	68	26	170
Totals	15	388	17	149	66	635

TABLE XLVIII. *Maternal Alcoholism & where the Daughter spends her Spare Time (Edinburgh).*

Where daughter spends her time	Mother: Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
House	7	189	9	70	18	293
Part house...		48	3	20	7	78
Part streets	6	47	3	21	7	84
Streets	1	44	3	51	11	110
Totals ...	14	328	18	162	43	565

TABLE XLIX. *Where the Son spends his Spare Time & his Acuity of Vision (Edinburgh).*

Acuity of vision of son	Son: House	Part house	House and outdoor occupation	Part streets	Streets	Totals
Normal	187	38	51	58	129	463
6/9	29	12	5	11	11	68
6/12 ...	9	6	2	5	5	27
6/18 ...	23	6	7	10	19	65
6/24 ...	5	1	1		3	10
Rest ...	6	1	1	3	2	13
Totals...	259	64	67	87	169	646

TABLE L. *Where the Daughter spends her Spare Time & her Acuity of Vision (Edinburgh).*

Acuity of vision of daughter	Daughter: House	Part house	Part streets	Streets	Totals
Normal	192	45	55	55	347
6/9	37	16	17	5	75
6/12 ...	15	8	11	2	36
6/18 ...	34	5	13	4	56
6/24 ...	7	1	1	4	13
Rest ...	1	1		5	7
Totals...	286	76	97	75	534

TABLE LI. *Where the Son spends his Spare Time & his Refraction (Edinburgh).*

Son

Refraction of son	House	Part house	House and outdoor occupation	Part streets	Streets	Totals
Normal	340	59	101	98	252	850
Hypermetropia	85	35	14	33	42	209
Hypermetropic astigmatism	60	26	11	29	19	145
Mixed astig.	20	6	5	6	8	45
Myopia and myopic astig.	13	2	3	8	17	43
Totals......	518	128	134	174	338	1292

TABLE LII. *Where the Daughter spends her Spare Time & her Refraction (Edinburgh).*

Daughter

Refraction of daughter	House	Part house	Part streets	Streets	Totals
Normal	361	66	98	110	635
Hypermetropia	76	42	36	16	170
Hypermetropic astigmatism	88	28	28	14	158
Mixed astig.	30	5	16	5	56
Myopia and myopic astig.	17	11	16	5	49
Totals......	572	152	194	150	1068

TABLE LIII. *Paternal Alcoholism & Number of Dead Children (Edinburgh).*

Father

Number of dead children	Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
0	4	92	4	57	28	185
1		54	6	59	22	141
2	3	46	6	37	30	122
3	2	31		27	18	78
4	2	18		22	7	49
5		9	1	10	7	27
6		5		3	2	10
7	1	4	1	5		11
8	2		1	3	1	7
9		1		2	1	4
10						
11		1				1
Totals ...	14	261	19	225	116	635

TABLE LIV. *Paternal Alcoholism & total Number of Children (Edinburgh).*

Father

Total number of children	Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
1		9	1	3	5	18
2		21	2	8	6	37
3	2	24	1	23	11	61
4	1	31		24	14	70
5	1	32	4	31	18	86
6	3	37		38	13	91
7		35	4	38	16	93
8	1	35	4	17	12	69
9	1	13	1	21	6	42
10	2	5		11	6	24
11	2	11	1	7	6	27
12		7		4	2	13
13			1		1	2
14	1					1
15		1				1
Totals ...	14	261	19	225	116	635

TABLE LV. *Maternal Alcoholism & Number of Dead Children (Edinburgh).*

Mother

Number of dead children	Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
0	4	133	7	45	14	203
1	1	93	3	46	11	154
2	3	80	3	28	14	128
3	1	46	3	24	10	84
4	2	27	1	16	3	49
5		17	1	9	4	31
6		8		2	3	13
7	1	2	1	6	1	11
8	1	1		4	2	8
9		1		2		3
10						
11		1				1
Totals ...	13	409	19	182	62	685

TABLE LVI. *Maternal Alcoholism & total Number of Children (Edinburgh).*

Mother

Total number of children	Teeto-taller	Sober	Drink sus-pected	Drinks	Bouts	Totals
1		14	1	4	3	22
2		28	2	9	3	42
3	2	37	1	17	5	62
4	2	46	3	20	3	74
5		70	2	16	10	98
6	2	61	2	29	6	100
7		46	2	37	11	96
8	2	47	3	16	8	76
9	1	24	1	11	6	43
10	1	9	2	8	4	24
11	2	17		8	1	28
12	1	7		5	2	15
13		1		1		2
14				1		1
15		2				2
Totals ...	13	409	19	182	62	685

TABLE LVII. *Paternal Alcoholism & Number of Dead Children (Manchester).*

Number of dead children	Father: Temperate	Father: Intemperate	Totals
0	174	39	213
1	113	31	144
2	72	22	94
3	41	20	61
4	23	15	38
5	13	6	19
6	5	2	7
7	7	3	10
8	6	5	11
9		1	1
10			
11	1	2	3
Totals	455	146	601

TABLE LVIII. *Maternal Alcoholism & Number of Dead Children (Manchester).*

Number of dead children	Mother: Temperate	Mother: Intemperate	Totals
0	135	21	156
1	106	9	115
2	65	10	75
3	33	9	42
4	19	7	26
5	13	4	17
6	5		5
7	7	2	9
8	6	1	7
9			
10			
11		1	1
Totals	389	64	453

TABLE LIX. *Paternal Alcoholism & total Number of Children (Manchester).*

Total number of children	Father: Temperate	Father: Intemperate	Totals
1	13	3	16
2	51	10	61
3	53	11	64
4	60	17	77
5	66	17	83
6	59	23	82
7	41	18	59
8	27	9	36
9	28	9	37
10	23	9	32
11	11	5	16
12	15	4	19
13	4	4	8
14	2	1	3
15	1	3	4
16	1	1	2
17		2	2
Totals	455	146	601

TABLE LX. *Maternal Alcoholism & total Number of Children (Manchester).*

Total number of children	Mother: Temperate	Mother: Intemperate	Totals
1	12	2	14
2	26	5	31
3	54	5	59
4	52	8	60
5	58	9	67
6	53	11	64
7	35	3	38
8	23	5	28
9	24	4	28
10	22	5	27
11	9	2	11
12	15	2	17
13	2	2	4
14	1		1
15	1		1
16	2		2
17		1	1
Totals	389	64	453

Table LXI. *Number of Dead Children & total Number of Children (Manchester).*

Number of dead children

Total number of children	0	1	2	3	4	5	6	7	8	9	10	11	Totals
1	16												16
2	51	10											61
3	40	20	4										64
4	32	34	7	4									77
5	32	29	16	4	2								83
6	22	24	17	14	4	1							82
7	10	10	18	11	7	2	1						59
8	6	7	11	8	2	2							36
9	2	8	9	10	5		1	1	1				37
10	1	1	7	6	9	5	1	2					32
11		1	1	3	5	2		2	2				16
12	1		1	1	3	4	2	2	5				19
13			2		1	1	1	2	1				8
14						1		1		1			3
15			1			1	1					1	4
16									2				2
17												2	2
Totals ...	213	144	94	61	38	19	7	10	11	1		3	601

Table LXII. *Number of Dead Children & total Number of Children (Edinburgh).*

Number of dead children

Total number of children	0	1	2	3	4	5	6	7	8	9	10	11	Totals
1	22												22
2	33	9											42
3	43	14	5										62
4	35	23	14	2									74
5	27	34	27	9	1								98
6	21	30	22	18	7	2							100
7	14	22	24	26	7	3							96
8	7	12	20	13	9	11	2	2					76
9	1	10	9	7	10	2	3	1					43
10			2	4	2	7	2	3	3	1			24
11			2	5	11	2	4	2	1	1			28
12			2		2	3	2	3	2	1			15
13			1			1							2
14									1				1
15									1			1	2
Totals...	203	154	128	84	49	31	13	11	8	3		1	685

LXIII. DEVIATIONS FROM THE SCALE LINE BETWEEN ALCOHOLIC AND NON-ALCOHOLIC PARENTS MEASURED IN TERMS OF THE STANDARD DEVIATION.

(i) *Paternal Alcoholism (Manchester).* (ii) *Maternal Alcoholism (Manchester).*

	Grade of Alcoholism (i)		Grade of Alcoholism (ii)	
Health of child	Son	Daughter	Son	Daughter
Healthy	−·62	−·54	−1·02	−1·08
Delicate	−·70	−·52	−·93	−·95
Phthisis and epilepsy	−·92	−·98	−1·50	−1·58
Died young	−·71	−·48	−1·21	−·98
Mean Alcoholism	−·67	−·56	−1·06	−1·08

(iii) *Paternal Alcoholism (Edinburgh).* (iv) *Maternal Alcoholism (Edinburgh).*

Health of child	Grade of Alcoholism (iii)	Grade of Alcoholism (iv)
Healthy	·20	−·21
Glands	·26	−·13
Heart	·30	−·29
Chest	·43	−·39
Other diseases	−·15	−·57
Mean Alcoholism	·22	−·23

(v) *Paternal Alcoholism (Edinburgh).* (vi) *Maternal Alcoholism (Edinburgh).*

	Grade of Alcoholism (v)		Grade of Alcoholism (vi)	
Intelligence	Son	Daughter	Son	Daughter
Excellent	·06	·13	−·39	−·17
Good	·08	·23	−·34	−·39
Medium	·17	·15	−·45	−·27
Dull	−·02	·26	−·37	−·14
Mean Alcoholism	·09	·20	−·39	−·29

(vii) *Paternal Alcoholism (Edinburgh).* (viii) *Maternal Alcoholism (Edinburgh).*

	Grade of Alcoholism (vii)		Grade of Alcoholism (viii)	
Refraction	Son	Daughter	Son	Daughter
Normal	·25	·22	−·32	−·23
Hypermetropia	−·08	·15	−·36	−·47
Hypermetropic astigmatism	−·10	·29	−·34	−·36
Mixed astigmatism	·28	−·16	−·78	−·41
Myopic astigmatism	·21	−·10	−·93	−·24
Mean Alcoholism	·15	·19	−·36	−·29

(ix) *Paternal Alcoholism (Edinburgh).* (x) *Maternal Alcoholism (Edinburgh).*

	Grade of Alcoholism (ix)		Grade of Alcoholism (x)	
Acuity of Vision	Son	Daughter	Son	Daughter
Normal	·22	·20	−·33	−·27
6/9	−·24	·00	−·46	−·53
6/12	·10	·38	−·50	·00
6/18	·02	·19	−·45	−·48
Rest	·43	·15	−·34	·15
Mean Alcoholism	·15	·18	−·37	−·28

The meaning of these tables is as follows: The standard deviation, on the basis of a normal distribution of the alcoholic taste, is taken as our arbitrary scale unit. The zero of the scale is the line between sober and alcoholic in the estimation of the observer. Thus in (i) we have on this scale the average

amounts of alcoholism of fathers of sons of different health categories. The mean parent possesses the grade $-\cdot67$ of alcoholism, *i.e.* is "negatively alcoholic" or sober. The parent of healthy children is less sober $(-\cdot62)$ than the mean, and the parent of phthisical and epileptic children has a considerably greater degree of average sobriety than the mean parent.

LXIV. DEVIATIONS FROM THE SCALE LINE BETWEEN SPENDING THE TIME IN THE HOUSE AND SPENDING THE TIME IN THE STREETS MEASURED IN TERMS OF THE STANDARD DEVIATION.

(i) *Where the Child spends its Time (Edinburgh).*

Refraction	Grade of Time in Streets Son	Daughter
Normal	$-\cdot52$	$-\cdot92$
Hypermetropia	$-\cdot82$	$-1\cdot29$
Hypermetropic Astigmatism	$-1\cdot10$	$-1\cdot32$
Mixed Astigmatism	$-\cdot90$	$-1\cdot32$
Myopic Astigmatism	$-\cdot26$	$-1\cdot24$
Mean Place where Child spends Time ...	$-\cdot62$	$-1\cdot06$

(ii) *Where the Child spends its Time (Edinburgh).*

Acuity of Vision	Grade of Time in Streets Son	Daughter
Normal	$-\cdot59$	$-1\cdot00$
6/9	$-\cdot99$	$-1\cdot50$
6/12	$-\cdot90$	$-1\cdot59$
6/18	$-\cdot55$	$-1\cdot46$
Rest	$-\cdot78$	$-\cdot14$
Mean Place where Child spends Time ...	$-\cdot64$	$-1\cdot08$

Table LXIV is constructed on the same principle. The amount of time spent in the streets by the child takes the place of the parent's alcoholic tendency, and its standard deviation is the arbitrary scale unit. The zero of the scale is all spare time in the streets. The mean boy in (i) spends a negative amount of time in the streets, *i.e.* he stands at $-\cdot62$ on this scale. The mean girl at $-1\cdot06$, or she is still longer indoors. An emetropic boy is more $(-\cdot52)$ in the streets than the mean boy, and a myopic boy $(-\cdot26)$ more in the streets than the emetropic boy. The emetropic girl is more $(-\cdot92)$ in the streets than the mean girl $(-1\cdot06)$, but the myopic girl is more $(-1\cdot24)$ in the house than the emetropic girl, but less in the house than the astigmatic and hypermetropic girls.

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UNIVERSITY OF LONDON

FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

EUGENICS LABORATORY MEMOIRS. XIII.

A SECOND STUDY OF THE INFLUENCE OF PARENTAL ALCOHOLISM ON THE PHYSIQUE AND ABILITY OF THE OFFSPRING

BEING A REPLY TO CERTAIN MEDICAL CRITICS OF THE FIRST MEMOIR AND AN EXAMINATION OF THE REBUTTING EVIDENCE CITED BY THEM

BY

KARL PEARSON, F.R.S.

AND

ETHEL M. ELDERTON,

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WITH 3 DIAGRAMS IN THE TEXT

LONDON:

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CONTENTS

THE TREASURY OF HUMAN INHERITANCE

ISSUED BY

THE FRANCIS GALTON LABORATORY FOR NATIONAL EUGENICS

The Francis Galton Laboratory is issuing in parts at short intervals a collection of published and unpublished family pedigrees, illustrating the inheritance in man of mental and physical characters, of disease and of abnormality.

Students of heredity find great difficulty in obtaining easy access to material bearing on human inheritance. The published material is voluminous, scattered over a wide and often very inaccessible journalistic area. The already collected although unpublished material is probably as copious, but no central organ for its rapid publication in a standardized form exists at present. The Eugenics Laboratory alone possesses several hundred pedigrees of family characteristics and diseases which it is desirable to make readily accessible. Many medical men possess similar material, and there is a growing desire among genealogists to pay more attention to family characters and supplement the merely nominal pedigrees current in the past.

For a publication of this kind to be successful at the present time, it should be entirely free from controversial matter. The *Treasury of Human Inheritance* will therefore contain no reference to theoretical opinions. It will give in a standardized form the pedigree of each stock. This will be accompanied by a few pages of text describing the individual members of the stock, giving references to authorities, and, if the material has been published, to the *locus* of original publication. When necessary the characteristic will be illustrated by photography or radiography. In this way, it is hoped in the course of a few years to place a large mass of material in the hands of the student of human heredity. It will not cut him off from, but directly guide him to original and fuller sources of information. Further, the *Treasury* will provide students of eugenics and of sociology, medical men, and others, with an organ where their investigations will find ready publication, and where as time goes on a higher and more complete standard of family history than has hitherto been usual can be maintained. It is proposed to issue the *Treasury of Human Inheritance* in quarto parts at about quarterly intervals. Each part will contain about 6 to 10 plates of pedigrees and of such other illustrations as may be needful.

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Single parts may be purchased from Messrs Dulau & Co., Ltd., 37, Soho Square, London, W., either directly or through any bookseller.

PREFATORY NOTE

THE following reply to certain medical critics of our first memoir, accompanied by an examination of the rebutting evidence cited by them, is issued with no delight in controversy. The staff of the Galton Laboratory has far too much urgent work in hand—work which its members think of great social value, and with the magnitude of which their present resources are quite unable to cope—to take pleasure in demonstrating the fallacies of their critics. But we look upon the problem of alcohol as a great national problem, and a problem with which the nation can only hope to cope when it knows the actual facts as to alcohol. These facts are not known at present; they are obscured by passionate rhetoric and hopeless bias. Taking the *extreme* cases of alcoholism, cases where at least we have certainty of its evil effects on the individual—which is far more than we can assert of its customary and moderate use—we find alcoholism associated in the individual with mental defect. This *association* has been everywhere interpreted by the advocates of temperance as *causation*. They have never investigated whether the mental defect was antecedent to or consequent on the alcoholism, or how far it was partly one or partly the other. The family histories collected during some years in the Galton Laboratory as well as masses of other data seemed to indicate definitely that *extreme* alcoholism was only consequent on the pre-existing degeneracy of the stock, it was not in itself an antecedent to such defectiveness. The arguments produced by medical temperance writers to show that alcoholism was the source of defectiveness in the offspring were found to be based on *selected* families, and internal evidence in the data given satisfied us that these families were actually degenerate stocks. To those who have studied the heredity of physical and mental defects and noted the frequent appearance of alcoholism in such stocks, it must appear the height of absurdity to attribute deaf-mutism, dwarfism and physical deformity to parental alcoholism. And yet it is impossible to trace a long pedigree of deaf-mutism or of split hand and foot without coming across many associated cases of alcoholism. It is precisely so in the matter of albinism; it is quite easy to pick out pedigrees closely associated with imbecility and extreme alcoholism. If extreme alcoholism therefore be, as we believe from our data, a consequent and not an antecedent of defectiveness, then of what service for eugenic purposes can be a campaign which confuses all grades of alcohol users, and which would not reach the root of the matter, if it succeeded in cutting off entirely all opportunities for the procuring of alcohol? The problem in its truly national form, is the fundamental

problem of restrictive eugenics; it is summed up in the words: "Endeavour to cut off at its source the production of degenerate stocks." One step only in this direction—the segregation of the mentally defective—would affect at least 50% of the persons who ultimately find their way into prison, asylum, and inebriate reformatory. Thus our controversy with the medical temperance writers is not a personal one, it has a very close bearing on the most urgent problem of social reform. The question of whether extreme alcoholism is consequent on or antecedent to mental defect is a fundamental question at the present day. It is being obscured by the vague and unproven assertions of our opponents that every glass of beer, every drop of alcohol which the parent consumes produces its quantum of stupidity in the offspring. If therefore we appear to those, who run but do not read, to be opposing what they term a great social crusade, it is because we think, and shall continue to think, until substantial evidence is brought to the contrary, that alcohol is in its pernicious forms consequent on and not antecedent to mental defect, and that the rational solution of the alcohol problem must be reached by attacking mental defect and not by abusing unprejudiced students of the subject.

E. M. E.
K. P.

A Second Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring

Much of the literature of alcoholism is of a rhetorical rather than scientific order, and the sooner scientific order and method are introduced the better.—*Sir Clifford Allbutt.*

(1) *General Reply to the Medical Critics of the First Eugenics Laboratory Memoir on Parental Alcoholism.* It is not an easy task to reply to the long series of misinterpretations and positive misstatements with regard to the conclusions of the first Eugenics Laboratory memoir on alcohol, which have been issued by the temperance press. The authors have been accused of every scientific blunder and of most social and moral delinquencies. That such would be the attitude of many individuals, who believe that their particular method of solving the social difficulties attending the excessive use of alcohol must be pushed either by true or false evidence we fully anticipated, and we gave expression to our anticipation in the concluding paragraph of our first paper.

Our own position was very fully defined beforehand. We realised the question of intemperance as one of the chief problems of our national life, and believed it to be one that essentially came under the definition of National Eugenics which alone controls the work of this Laboratory*. But, as in other cases, we were resolved to test these alcoholic problems for ourselves, by our own methods, and on material which had not been collected by any *ex parte* recorders already pledged to definite opinions. Our memoir was the first of a series of which the third is now at press, and may, though we would hope will not, provide further material for the vituperation and invective which has followed the first issue.

We propose in the present memoir to analyse some of the criticisms that have been made of the material dealt with in our paper, and to examine the weight of some of the rebutting evidence which has been brought forward by our critics. Of the many misstatements made with regard to ourselves only two must be corrected here, because they have some importance with regard to the Galton Laboratory for National Eugenics. Two of the most vigorous temperance advocates, Sir Victor Horsley and Dr C. W. Saleeby, alike in that they make very dogmatic assertions without either sufficient knowledge or reasonable criticism of their sources of information, have chosen to make very definite statements with regard to this Laboratory. They are absurd to any one with knowledge of the facts, but they do harm to the reputation of the Laboratory in quarters where

* "National Eugenics is the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally." This definition was adopted as a guide to the work of the Laboratory on its foundation in 1907, when the older "Eugenics Office" was replaced by the Eugenics Laboratory.

those facts are not known. Sir Victor Horsley on July 28th, 1910, at a breakfast of the National Temperance League, said of the first memoir that it "is a most unhappy one; and it has been disowned by the Chairman of the Eugenics Society, for which Miss Elderton and Professor Pearson are working." This statement was at once contradicted in the *British Medical Journal* (August 13, 1910). The Eugenics Laboratory is under the control of the University of London; it has no relation whatever to the Eugenics Education Society, of which the authors are not even members, and the sole link between the two lies in the fact that our Founder is Honorary President of the Society. Notwithstanding this contradiction, which could hardly escape Sir Victor Horsley's attention, he has allowed the statement to be repeated under his name in the *National Temperance Quarterly* for September (p. 144). The second misstatement to which it is needful to refer occurs in a paper by Dr C. W. Saleeby in the *British Journal of Inebriety*, Vol. VIII. p. 54, and runs as follows: "When he founded the Eugenics Laboratory, now several years ago, Mr Galton, as he was then, asked the present writer and one or two others to meet the staff of the Laboratory once a month, but only two or three such meetings were sufficient to show more than one of us that no good was to be done. If the present biometricians were biologists, as their founder was," then, Dr Saleeby tells us, their patience would be of service and they would accept medical aid*. The Eugenics Laboratory came into existence and was first called by its present name in 1907, when the present Director took up the reins; it was then for the first time associated with the Biometric Laboratory at University College and its official publications were then first started. The present staff of the Laboratory did not come into existence till 1907, and as Dr Saleeby must know perfectly well, he has never met the "present biometricians" in committee or council of any sort connected with the Laboratory; nor has he had at any time a voice in its councils; it would have entirely precluded the present staff from joining it had he been in any way associated with its activities. The old "Eugenics Record Office," which existed before 1907 had a biologist as its research fellow and the chairman at the gathering to which Dr Saleeby refers was, we understand, a biologist also. Dr Saleeby by a *suggestio falsi* has led the public to suppose that the present Laboratory was at one time aided by an advisory committee of which he was a member and which would have guided, but for their perversity, the "present biometricians." Thus Dr Basil Price (*National Temperance Quarterly*, Vol. VIII. p. 176) talks about "the committee originally formed to supervise the Galton Laboratory Reports." Men of science are not in the habit of submitting their researches for supervision to committees of the kind suggested by Dr Saleeby and Sir Victor Horsley, and the sole responsibility for publication in the case of the Eugenics Laboratory has always rested with the Director, as the

* Dr Saleeby states (*British Journal of Inebriety*, Vol. VIII. p. 53) that he abandoned medical practice in 1902 to devote himself to the study and advocacy of eugenics. His first qualifying medical degree dates from 1901.

responsibility for ultimate choice of subjects has rested with the individual workers. This does not connote that the Laboratory rejects medical aid; there has never been a time since its present organisation, which dates from 1907, when it has not sought and obtained, whether dealing with alcoholism, insanity, tuberculosis, eyesight, or heredity of disease, the help of the medical profession. This help has been always sought for and has been given most generously, and one of the humours of the situation has been to find the more talkative but far less authoritative members of that profession criticising statements made in our memoirs as those of "mere mathematicians" when these had actually received the sanction of men of far greater weight in their own faculty! It is perfectly open to Sir Victor Horsley and his comrade in arms Dr Saleeby to condemn to their hearts' content the publications of this Laboratory; that they make statements with regard to its constitution which are misleading or wholly false exceeds the limits of legitimate criticism. From Sir Victor Horsley we had anticipated immediate and frank acknowledgment of his error.

If we turn to our critics they naturally divide themselves into three classes. In the first place we have the paid officials, or platform orators of various temperance organisations; their criticisms have no scientific value and will not be noticed here. In the next place we have two or three economists, who have attacked the memoir on the ground that the populations dealt with were not fair samples of the working class population. They have been fully dealt with in a *Supplement* to the original memoir issued in September*. They will only be incidentally mentioned in this paper. It is a noteworthy fact that Sir Thomas P. Whittaker, with that *Supplement* before him, restates the arguments of these economists without one word of reference to the rejoinders made to them! Until the replies made to the economists have been met, it is idle to repeat them here. The question therefore of the representative character of our samples will only be referred to incidentally. Lastly we have the third class of critics, those with special medical training who have written on the subject of alcohol and profess to have studied its literature. It is this class of critics to whom we shall devote our present space.

Now the characteristic feature of the English literature of alcohol is the total absence of any original investigation on the point we had under discussion, namely the influence of parental alcoholism on the offspring. Our critics repeat each other and cite two or three well-known continental and American authorities, Demme, Bezzola, Laitinen and MacNicholl. In the bulk of these cases they give no reference whatever to the locus of the original papers and there is more than a shrewd suspicion that they have never read them. What is quite certain is that they have never examined them with a view to ascertaining whether the originals are statistically self-consistent. They talk about the "weighty statement" of Demme, about the "careful evidence" of MacNicholl or the "well-

* *Supplement to the Memoir entitled: The Influence of Parental Alcoholism on the Physique and Ability of the Offspring.* Questions of the Day and the Fray, No. I. Dulau and Co., Soho Square.

known work" of Bezzola. Or again, these gentlemen cite each other: "Only an insignificant number of drinkers' children are physically sound, Sir Victor Horsley tells us," writes Dr Johnston*, but he gives us no reference to the book and page, and Sir Victor Horsley's writings may be sought in vain for any *independent* statistics. "The child of the alcoholic mother is often dying before it is born. Five times as many alcoholised infants die as those of sober mothers," says Mr Pearce Gould. But we are given no reference where we can verify the statistics upon which these statements are based. Or again, "Dr Saleeby has told us that when formerly working in the slums of Edinburgh and York, he attended the birth of children who were born drunk." We ask in vain for a reference to the original paper, that we may duly appreciate the signs by which this clinician diagnosed drunkenness in the newly-born baby. These things may be true or they may be false, their reiteration by one writer on temperance after another without any examination of the original data is one of the signs of how thoroughly unscientific is and has been the English discussion of this vital problem.

We propose to illustrate this by first stating the sort of criticisms that have been made of our memoir, and then applying them to the material which these medical temperance authorities cite as demonstrating that our data are valueless.

(2) *MacNicholl's Data.* We found in Edinburgh that 54 °/₀ of the fathers drank, *i.e.* took more alcohol than the social workers, police and their employers considered good for them†; 24 °/₀ of the fathers of the mentally defective children drank in the case of Manchester. In the supplement to our memoir we indicate that data are forthcoming to show that 20 °/₀ to 40 °/₀ of the workers in the Lancashire towns are "drinkers" in the sense in which we have applied the term in the Edinburgh data. Now what are the criticisms made of these results?

(i) That not a layman but only a medical man can determine whether a person is alcoholic or not.

(ii) That the proportion of 25 °/₀ of alcoholic parents in the population cannot possibly be correct, and that accordingly our data apply only to a degenerate population, and are unreliable‡.

Now let us apply these results to Dr MacNicholl's American data which are quoted with high approval by Sir Victor Horsley (*Alcohol and the Human Body*, 1907, p. 325), Dr Saleeby (*British Journal of Inebriety*, Vol. VIII. p. 63), Dr Basil Price (*Ibid.* p. 72, from Horsley), Dr Claude Taylor (*National Tem-*

* *Alcohol, the Parent and Child*, First "Hicks" Counties Lecture, 1910.

† Sir Thomas P. Whittaker converts this into the statement that the fathers were known or suspected to be "drunken." We in our memoir used no such classification of "drunken."

‡ Even if the populations dealt with were the lower working classes, it would not affect the argument, as we have shewn in our *Supplement*. It is the *differential* influence of alcohol we are concerned with, and it is as reasonable to argue from its differential effect on a special class of man to all men, as to argue from its differential effect on mice or guinea-pigs to what occurs in the case of man.

perance Quarterly, September, 1910, p. 183, who again cites Horsley) and Dr T. Johnston (*Alcohol, the Parent and Child*, 1910, p. 10), who gives no reference at all.

We turn to Dr MacNicholl's paper. We find he reports on 55,000 school children of whom 10,790 were females and 44,210 males. He reports that he could not get as many details as he should have liked owing to the "numerous duties of the school teachers." In other words his analysis of the parental attitude to alcoholic drinks which was reported in 20,147 cases was a report *not* provided by a medical examination of the parents, but by laymen and these not trained social workers as in the case of our Edinburgh data. The trustworthy character of the records is therefore far less than that of our Edinburgh data, and much less than that of the Manchester data, where one parent was examined by a highly qualified medical man, and *the home visited* by a qualified social worker*.

In the next place the parents were only divided into *two* classes, *drinking* parents and *abstaining* parents. Will Sir Victor Horsley and Dr Basil Price assert that those *abstaining* parents were *total abstainers*? If so, they must be prepared to substantiate the fact that 67 °/。 of an American population which itself contained 32 °/。 of foreigners were total abstainers. There is, we think, small doubt that this 67 °/。 of abstainers, as reported by the school teachers, covers precisely the same class as we have called "sober" in the Edinburgh returns. In other words, Dr MacNicholl's classification of "drinking" and "abstaining" is precisely the "temperate" and "intemperate" of our Manchester (or Edinburgh) classification. And yet the very men who cite MacNicholl's data with the highest approval tell us that such broad classifications as we have used render our results futile! But note further what happens: there are 33 °/。 of drinking parents! This is exactly the percentage which our critics find marks a degenerate population, which we had no right to take as a sample to test the problem of alcoholism upon†! But we have not done yet! Not only have we been told that our classification was made by laymen, and that our samples represent a degenerate population with an enormous percentage of drinkers, but a third condition has been laid down as an essential for reaching any result of value. Here is what Sir Victor Horsley writes: "The enquiry purports to differentiate between alcoholic and non-alcoholic parentage, yet as Dr Sullivan points out, there is no indication as to whether the alcoholism had set in before the offspring were born! When children aged 14 are being investigated we require to know the habits of the parents fifteen or more years previously! Yet this simple precaution has been entirely overlooked" (*National Temperance Quarterly*, September, 1910, p. 181). Dr Basil Price writes: "No inquiry apparently was instituted into the habits of the parents *previous to* and *during* the conception of the children; a factor of every importance, the omission of which quite vitiates

* Dr MacNicholl (*Medical Temperance Review*, August, 1905, p. 246) gives no evidence whatever of home visitation or medical examination of the parents.

† Cf. Dr Keynes, who finds 25 °/。 of alcoholic parents impossible in a working class population.

the value of the report apart from other faults" (*Ibid.* p. 177). Their colleague Dr Saleeby writes that we have dealt with the influence of parental alcoholism on the physique and ability "*without troubling to inquire in a single case whether the alcoholism or the offspring came first*" (*British Journal of Inebriety*, Vol. VIII. p. 59).

Now let us assume for a moment this criticism to be a valid one, then what are we to think of the logical acumen of Sir Victor Horsley, who cites MacNicholl's results as of striking value? What must we hold to be the scientific weight of Dr Basil Price, who uses the MacNicholl data to rebut our conclusions? Or, lastly, of Dr Saleeby's rhetorical judgments, who quotes them as being authoritative? Either these writers have never studied MacNicholl's paper, or they find it sufficient to use a process when it supports their own conclusions, and then call it discredited when used to deduce results with which they are not in agreement.

Now every word that Sir Victor Horsley, in association with Dr Saleeby and Dr Basil Price, has applied to our method and memoir on this point applies with greater force to Dr MacNicholl's material. He has neglected to inquire whether the alcoholism or the offspring came first. He has not even provided the data which we gave to enable the importance of this knowledge to be tested, for he has not provided the ages of the children discussed by him. The illustration we have given here of the acumen, the logic and, we will venture to say, the fair play of these temperance medical critics is not unique, as we shall soon see. But in the face of it how can those sociological workers who wish to get at the truth trust any conclusions formed by such logicians? The intellect of man can be affected by toxicants more subtle than alcohol, and the most dangerous of these is the passion for collecting, without weighing, any statements which will support a prejudgment.

The actual answer to the difficulty raised by Sir Victor Horsley and Dr Saleeby could have been found by them at once had they studied the data in our memoir. Of the alcoholic parents a slightly *larger* percentage of the offspring falls between 5 and 7 years of age than in the case of the sober parents, 30 °/。 as against 27 °/。 and the ratio of the number of children between 5 and 7 to those between 12 and 14 is for *both* drinking and sober parents 1·6. But if the parents only became alcoholic to any sensible extent after the birth of their children*, it will be clear that the ratio of young to old offspring in the case of the alcoholic must be very different from what it is in the case of the sober parents. Actually the alcoholic have as many *young* children as the sober, and there is no place for a large number of the alcoholic to have become such after the birth of their children. The only artifice by which Sir Victor Horsley and Dr Saleeby could get out of this difficulty would be to assert that alcoholism never develops until the youngest children of a family are of school age. Granted this, however, we see that the assertion that alcoholism in the parent produces mental defect in the children must be idle, for all the children would be born before alcoholism begins!

* There is doubtless *some* development of alcoholism after the birth of the offspring, but the above statistics go a long way to show that it is not a widely spread tendency. The drinking parents have relatively as many *young* children as the sober.

But let us return to Dr MacNicholl, although we hardly know whether our medical critics will now retain or reject him as an authority*.

In mental defectiveness the following categories have been recognised: (i) the certifiably insane; (ii) very defective, congenital imbeciles, degenerates and epileptics; (iii) defective, eccentric, silly, dull, senile, or subject to periodical paroxysms of ungovernable temper probably of an epileptic character; (iv) backward, generally incapable of average attainments in more abstract matters and much behind in school work; (v) all those of normal intelligence. Of these divisions, (i), (ii) and (iii) cover what are termed the mentally defective in the scholastic sense. In London they amount to a little over 1 °/₀, certainly not 2 °/₀. Class (iv) covers probably about 5 °/₀ to 10 °/₀ of the children. Now Dr Basil Price talks about Dr MacNicholl studying mental deficiency in school children and speaks of the effect of parental inebriety on the production of the *feeble-minded* (the italics are his). Sir Victor Horsley tells us that 55,000 children were examined by Dr MacNicholl and that he found 17 °/₀ actual "dullards," 25 °/₀ "very deficient" and 16 °/₀ "deficient." This is not exactly Dr MacNicholl's own statement; he says that 25 °/₀ were "very deficient," 17 °/₀ "dullards" and 16 °/₀ "below standard†." Only 42 °/₀ were "standard" or of normal intelligence. Now nothing like this has ever been our experience in dealing with large quantities of English school data. Dr MacNicholl does not define his terms, but presumably "below standard" roughly corresponds to our class (iv), which contains 8 °/₀ to 10 °/₀ of children. Below this MacNicholl places 25 °/₀ of "very deficients" and 17 °/₀ of "dullards," as against the less than 2 °/₀ of such cases found in England. Is it not obvious that we are dealing with either a wholly exceptional population or with an estimation of mental deficiency which is entirely fallacious? Among our 1092 Edinburgh children 29 were "defective" and 170 "dull," or 2·7 °/₀ and 15·8 °/₀ respectively. These are large values compared to the London 2 °/₀ and 10 °/₀. But what do the critics who assert that our Edinburgh population was not a fair sample and could not be used to demonstrate anything say when they have a population 25 °/₀ deficient and 33 °/₀ dull? Why, they accept it without comment and use it as a normal population to discuss the influence of parental alcohol on the offspring! It is impossible to believe that they have ever examined Dr MacNicholl's paper.

Again Professor Marshall, Dr Keynes and Sir T. P. Whittaker have all alike asserted that the 30 °/₀ of drinkers in Manchester and 54 °/₀ in Edinburgh were

* Will they apply to Dr MacNicholl the criticism of their own great authority, Sir T. P. Whittaker, *i.e.* "the attempt to determine the influence of parental alcoholism on the physique and ability of the offspring, when he does not know whether the parents upon whose present habits he bases his elaborate calculations and extraordinary conclusions, were sober or drunken in the years prior to and at the time the children were begotten, is an absurdity. It is to erect a pretentious but entirely fallacious argument upon an absolutely rotten foundation"?

† In an authoritative paper Dr Luther H. Gulick (*Medical Record*, New York, July 28, 1906, p. 125) states that "there is a small percentage of children—from one-half of one to two per cent.—so below grade mentally as to be incapable of the most profitable education in classes with average children." These numbers agree with European experience, but not with Dr MacNicholl's extraordinary figures.

incompatible with the deduction of any results bearing on the problem of alcoholism. Yet Dr MacNicholl obtained a family history of 3711 children and found in this case that 73 °/。 of the parents drank! His material, however, is good enough to be used by Sir Victor Horsley and Dr Saleeby as evidence of the superiority of sobriety. Nay, not only in this population of children were 34 °/。 child-drinkers, but in the 55,000 previously referred to 27 °/。 were child-drinkers. In the schools with which Dr MacNicholl is dealing he tells us of children staggering drunk into the schoolroom, or of children by the ten being found in a state of intoxication, of boys going about with beer cards which were stamped with a hole each time they got a glass of beer, the boys with the most holes per month getting prizes. This is the population upon which Sir Victor Horsley thinks it suitable to test social problems! We should like to have Professor Marshall's views with regard to it. The population of 3711 children with 73 °/。 of drinking parents, 34 °/。 of drinking children, 81 °/。 of "dullards" and 64 °/。 of "neurosis or organic disease" is treated by Sir Victor Horsley and Dr Basil Price as a fair sample of a population upon which the evils of parental alcoholism can be measured, while our Edinburgh and Manchester data with nothing like these signs of general degeneracy is said by such critics to be irrelevant. Neither Sir Victor Horsley nor Dr Basil Price draws anywhere attention to this extraordinary state of affairs; they quote Dr MacNicholl with complacency and this although he has nowhere in his paper given us the information by which we could discriminate *whether the drinking of the parents, or the beer and spirit drinking of the children themselves was the source of the extraordinary amount of degeneracy found in the child population.* Sir Victor Horsley terms these children "ordinary children" (*Alcohol and the Human Body*, p. 324), and Dr Basil Price* without any comment cites these data as illustrating the effects of parental inebriety on the offspring. In a further paper ("Alcohol and the Disabilities of School Children," *The Journal of the American Medical Association*, Vol. 48, pp. 396—8, Chicago, 1907) Dr MacNicholl gives still more surprising results. He tells us that in some schools less than 20 °/。 and in some classes less than 2 °/。 of the children were found absolutely normal in body and mind. An examination of the records of 63,000 school children in 150 schools and 1749 classes showed 25 °/。 very deficient and 58 °/。 "below standard." Of 10,000 children in city schools 35 °/。 had diseases of the heart, 27 °/。 were tuberculous, 60 °/。 anaemic and 80 °/。 suffered from some neurosis, *i.e.* each child had on an average 2¼ defects. So common, he tells us, are organic and functional disorders in New York city that should those afflicted be excluded two-thirds of the schools would be compelled to close their doors. He divided the children into

* Dr Basil Price complains of the "looseness" of our data when we accept Dr Ashby's "temperate" and "intemperate" as a classification of the Manchester population. Yet he accepts without a murmur MacNicholl's "drinking" and "abstaining," although the former might contain everybody, from one drinking a glass of beer a year to the chronic inebriate! In no single word does he question such vague terms, used by MacNicholl without any verbal definition, as "dullard," "standard," "below standard" and so forth.

two classes (*a*) and (*b*), the division being between "good or prosperous" and "poor" circumstances. In (*a*) 30 °/₀ of the boys smoke, in (*b*) 80 °/₀ of the boys smoke. In considering the habits of drinking among the *children* he reports in 34,000 cases of (*a*) 73 °/₀ abstainers, 23 °/₀ drinkers of beer, drinkers of spirits 4 °/₀, drinkers of beer and spirits 12 °/₀. In 6879 cases of (*b*) there were 50 °/₀ abstainers, 43 °/₀ beer drinkers, 7 °/₀ spirit drinkers and 40 °/₀ drinkers of both beer and spirits. In class (*a*), 32 °/₀ have drinking parents, 68 °/₀ abstaining; in class (*b*) 85 °/₀ have drinking parents, 15 °/₀ abstaining. It will be interesting to hear what the critics of our Edinburgh population with 54 °/₀ of drinkers say to a population with 85 °/₀ of drinking parents, which is the condition of nearly one-sixth of the children examined in New York, the "good or prosperous" section having 32 °/₀ of drinking parents —our Manchester percentage. Will they now discard MacNicholl's work from the position it has been given in their writings? Will they also demand from him an inquiry as to whether the drinking and smoking of the children was not as much a cause as the drinking of their parents of their mental deficiency? *Will they also ask him why in no single instance in this material he has distinguished between the cases in which either one parent only or both parents drank?*

We may stay to consider here a further paper by Dr MacNicholl, which no doubt will ultimately meet with the approval of our medical temperance critics. It was read at the Eleventh International Congress on Alcoholism. It is published in the *Medical Temperance Review*, Vol. XII. pp. 53—6, 1909. Dr MacNicholl professes to have traced two hundred families, 100 with great grandparents in moderate and 100 with great grandparents in prosperous circumstances, through four generations and representing 35,266 individuals. The information given is so scanty that it is impossible to understand what Dr MacNicholl has really done. He tells us that "each and all of the great grandparents are classified as moderate drinkers, that is they were never intoxicated, but drank malt or spirituous liquors at regular intervals with or without their meals." As Dr MacNicholl tells us of the diseases (brain and nervous system, heart and lungs, liver, cancer, Bright's, etc.) from which each generation suffered, he must have knowledge of the last generation for at least 40 to 50 years; if we add two more generations to this, Dr MacNicholl's information must cover 90 to 100 years. Now it must be remembered that if we start with a family of 5, they will have 8 great grandparents; these four couples would give on an average 20 children, and one child of each of these families would go to make up the two couples who formed the grandparents; the two couples would produce on an average 5 children each. Thus on an average estimate a family of four generations consists of $8 + 20 + 10 + 5 = 43$ individuals. Dr MacNicholl has an average of 176 individuals, four times as many, in each of his families. He can only have obtained such numbers *by including cousins.* But on the average every five cousins he introduces means an additional four great grandparents. We must therefore understand that Dr MacNicholl is dealing with, not 8 but possibly 20 or 32 great grandparents, living nearly a century ago. These great grandparents for the 200 families would themselves provide a fairly big task, when we require to demonstrate, as Dr MacNicholl has done,

2—2

that (i) "each and all" were moderate drinkers and never intoxicated, (ii) that all were healthy and vigorous—another of Dr MacNicholl's conditions—and (iii) that they had no "indication of any organic or functional disease," for that excluded a family from the list. If Dr MacNicholl knows such facts for each of 35,266 persons, he has the greatest wealth of family pedigrees of any man living. We in the Eugenics Laboratory know the extreme—almost insurmountable—difficulty of getting this information for even *three* generations. And in view of this we call for the publication of those 200 pedigrees with detailed information as to the physical defects, chronic diseases and drinking habits of over 35,000 individuals. If they really are what they profess to be, this Laboratory is willing to publish them in Dr MacNicholl's name to-morrow.

But it is time to give Dr MacNicholl's conclusions. Starting with "each and all of the grandparents moderate drinkers," he provides the following data:

Great Grandparents in Moderate Circumstances.

	1st Gen.	2nd Gen.	3rd Gen.	4th Gen.
Moderate Drinkers......	100 °/。	41 °/。	22 °/。	38 °/。
Heavy Drinkers.........	0 °/。	18 °/。	10 °/。	4 °/。
Abstainers	0 °/。	40 °/。	67 °/。	57 °/。

Great Grandparents in Prosperous Circumstances.

	1st Gen.	2nd Gen.	3rd Gen.	4th Gen.
Moderate Drinkers......	100 °/。	61 °/。	50 °/。	27 °/。
Heavy Drinkers.........	0 °/。	8 °/。	10 °/。	5 °/。
Abstainers	0 °/。	30 °/。	39 °/。	67 °/。

Now we have a marked change here in the percentages of drinkers, we start with no abstainers and reach 57 °/。 to 67 °/。. The stocks are becoming less and less alcohol drinkers.

Now look at the result.

Physical Defectives.

Great grandparents	1st Gen.	2nd Gen.	3rd Gen.	4th Gen.
Moderate Circumstances......	0 °/。	80 °/。	87 °/。	92 °/。
Prosperous Circumstances ...	0 °/。	71 °/。	87 °/。	96 °/。

The chronic diseases show little regularity and hardly fluctuate beyond their probable error round 75 °/。 for generations 2, 3 and 4. Now here is a section of the very investigation Sir Victor Horsley has demanded (see p. 26 ftn.), an inquiry into the result of drinking during four generations, and what do we find? Why, that while abstainers form an increasing percentage in the 200 families, until they now, in the last generation, number 62 °/。 of the whole, the number of physical defectives has increased to such an extent that now only 6 °/。* of the fourth generation of these 200 families is without such defectiveness! We start with "each and all the grandparents" (a hundred years ago!) drinking, but without physical defect, we conclude with 62 °/。 abstainers but with only 6 °/。 free from physical defects. Surely the scoffers will say, What profits it to abstain, if only 6 °/。 of our

* Dr MacNicholl says 5 °/。.

children are normal? Not so Dr MacNicholl; he notes "the alarming harvest of abnormalities in the offspring, each generation showing more and more degeneration and greater susceptibility to disease," and puts his results for the two sets in the form

	1st Gen.	2nd Gen.	3rd Gen.	4th Gen.
Normal......	100 °/。	18 °/。	12 °/。	5 °/。

and concludes by the suggestion that "to the moderate drinker belongs no small share of responsibility for the mental and physical disabilities which now afflict the race." Now there is hardly a member of the professional and upper classes in this country to-day whose great grandparents were not "moderate drinkers," and probably at least their grandparents also. Will any one assert that all but 5 °/。 of those classes are degenerates or suffer from some physical defect? Yet all these ancestors according to Dr MacNicholl have constituted themselves possible progenitors and ancestors of a race that will "produce a harvest of victims for hospital, almshouse, insane asylum, and gaol. Once mental or physical deformities come within the grasp of this ubiquitous law, they transmit themselves to posterity with unerring facility" (p. 53). Under the circumstances why advocate abstinence? It seems to have been quite hopeless in its struggle against the "ubiquitous law" set going by these healthy and vigorous grandparents without chronic functional or organic disease, who condemned us by their moderate drinking to be only to the extent of 5 °/。 normal human beings.

To sum up, it can only be an exceptional English family whose great grandparents did not "each and all" drink moderately. The fact that 95 °/。 of physical defectives and degenerates do not exist among us is sufficient to show the complete futility of such statistics. Even if they were true, there would be as much logic in attributing the 95 °/。 of defectives to the increasing abstinence as to the "moderate drinking" of great grandparents; either is mere association, not demonstrated causation. Yet it is the material of such a writer which Sir Victor Horsley and Dr Saleeby hold worthy of scientific credence*!

(3) *Laitinen's Data.* The next illustrative example we will take is the paper by Professor Taav Laitinen of Helsingfors. This paper is published in the *Proceedings of the Twelfth International Congress on Alcoholism*, 1909, pp. 263—270. It is cited with great approval by Dr Saleeby and Sir Victor Horsley. Dr Saleeby terms Laitinen the "most patient and distinguished among living students of alcoholism." He states that the paper "surpasses in magnitude and precision all the many studies of this subject which have proved (!) the relation between drink and degeneracy."

Now Sir T. P. Whittaker accused the writers without a grain of evidence, and indeed without an atom of truth, of having "classed" as sober the families in which we only knew the relation of drink to *one* parent. Dr Saleeby, with his customary habit of talking before weighing evidence, cites Laitinen to support Sir T. P. Whittaker. The citation is apt, for Laitinen has done precisely what we did not do, but Sir T. P. Whittaker accused us of doing. He has *made no distinction*

* It is perhaps unnecessary to add that Dr MacNicholl again never informs us whether the drinking antedated or postdated the conception.

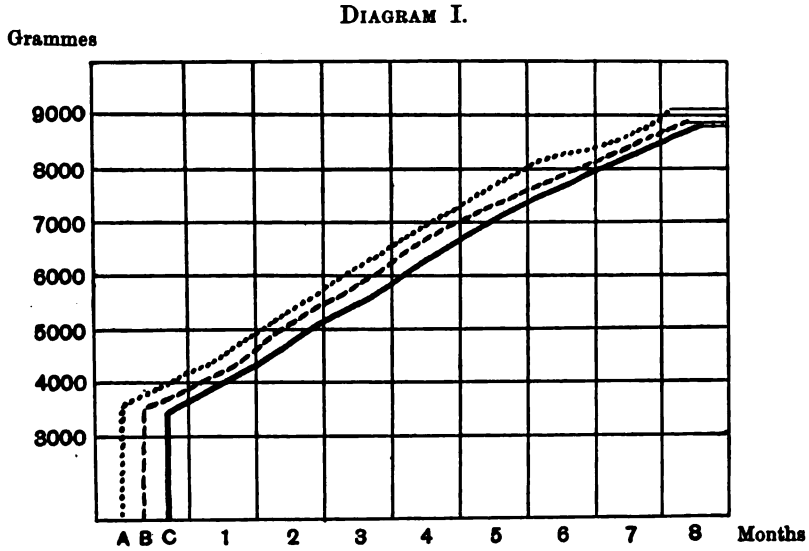
*between parents one of whom drank, or both of whom drank**. In our memoir, we showed exactly what Laitinen professes to show and what he is praised by Dr Saleeby for showing, namely that the weight of a child of an alcoholic parent was less than that of a sober parent. But because we distinguished between the cases of father and mother, which Laitinen fails to do, and because we measured the exact extent of the relationship, we were able to see that (i) the drinking of the mother had more influence than the drinking of the father, and (ii) that slight as was the effect since it influenced girls more than it influenced boys, it was unlikely to be due to toxic action on the foetus. We considered that possibly for school ages the influence on weight was due to another environmental factor; drinking mothers were more often employed than sober mothers, and that this threw more home duties on the girls of such mothers, and kept them more from play and exercise (*Memoir*, p. 7). But we kept our minds open: Edinburgh has not a very mixed population like that of Glasgow or Helsingfors, but we were prepared to learn that a racial difference existed between the more sober and more alcoholic classes (*Memoir*, p. 37). It is difficult to see where our results contradict those of Laitinen, who, we are told, has reached results "precisely opposed" to ours. Laitinen deals with three series of families, and each series is open to very serious objections. In the first case he issued 15,000 circulars—to medical men?—no, to the *parents* of new-born children, and he asked these parents to weigh their children for eight months and to say *themselves* whether they, the parents, were drinkers or abstainers. Of these circulars 2125 were returned, or *only* 14 °/₀. Thus laymen had to settle for themselves under which category they fell. Is it likely that the heavy drinker would fill in such a paper at all, still less weigh his baby once a month to provide, as he would naturally suspect, evidence for the well-known temperance professor on the subject of drink? We have been told that only a medical man can appreciate whether a person is alcoholic or not, yet when it suits their particular views our temperance critics will accept evidence to be provided by the drinker himself! Laitinen tells us that he terms "abstainer" a person who has either never taken alcohol or at least not since his marriage. By the term "moderate" he refers to a person who takes no more than one glass of beer a day and by a "drinker" he denotes a person who takes more than this. Now these may be his definitions, but in the circular—which he addresses thus: "Honourable Fellow-countrymen! You will do a great service to science if you will conscientiously fill in this circular respecting your new-born child during the first eight months of its life"—he merely asks if the parents are drinkers or abstainers and to state their daily consumption of beer and spirits. There is in the circular as he gives it no reference to the period during which they have drunk, or whether the period of abstinence has been during the marriage. This may have been ascertained in some other way, it is not referred to in the *questionnaire* as cited by Laitinen. Of this population, according to Laitinen, 60 °/₀ were "more or less drinking." The children, however, are classed under the heading of children of

* Laitinen asked for the information in his schedule, but if the information was given he has not used it.

"abstainers," "moderates," "drinkers." In not a *single* case out of 2125* is it noted that one parent drank and the other abstained! If this does not occur in large numbers in Finland, that country must be wholly different from the rest of Europe, where the men drink far more frequently than the women. It would be interesting to know how many heavy drinkers got into a series of this kind, and where a sober mother with a drinking husband was placed!

Laitinen gives tables of the average weights for eight months and graphs which are wholly deceptive and much exaggerate the apparent differences. This may not

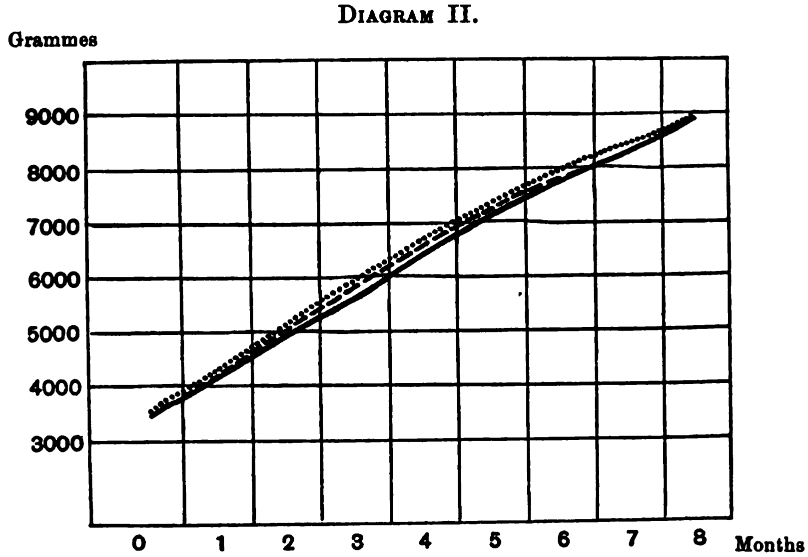
DIAGRAM I.



A Abstainers. *B* Moderates. *C* Drinkers.

After Prof. Laitinen, M.D., Helsingfors.

DIAGRAM II.



.... Abstainers. ------ Moderates. ——— Drinkers.

As Laitinen's Diagram would appear had he plotted his actual data.

* Nor indeed out of the later total of 5845.

be intentional, but this only demonstrates how wrong it is for those who have no statistical training to prepare statistical material. The fact is that the actual differences obtained are so insignificant on a diagram of the size used, that Professor Laitinen has thought it advisable to magnify them by the simple artifice of causing the baby of the abstainer to be born about two-thirds of a month earlier than the drinker's baby; the eye compares on each vertical ordinate the abstainer's baby at an age sensibly older than the drinker's baby!

Laitinen states his conclusion to be that the average weight of the abstainer's child is greater at birth, and that these children develop more rapidly during the first eight months than the moderate drinker's child, and the latter exceed in the same way the drinker's children. Now we think this statement is incorrect. It is a noteworthy fact that Laitinen finds a sexual difference between boys and girls, but that unlike our result for children of school age, where the weight of the girls was the more affected, he finds the difference in boys more significant than in girls. His numbers are somewhat erratic, probably due to vaccination and other troubles affecting the weight. But the following represents the measure of the difference:

Percentages by which Drinkers' Babies' Weights are less than those of Abstainers.

	When born	1 and 2 months old	7 and 8 months old
Girls......	3·6 °/。	4·4 °/。	2·2 °/。
Boys......	4·4 °/。	8·4 °/。	7·2 °/。

The "moderates" give somewhat less percentages in all cases. It is not correct to say that the abstainer's children develop more rapidly; the difference between the babies of abstainer and drinker is rather reduced in boys, and markedly reduced in girls. Laitinen also finds that the number of toothless children is greater at eight months with the drinkers; their children have one less tooth cut and the average age at first cutting is greater. All these results, equally visible in the children of the moderates (one glass or less of beer a day!), are attributed by Laitinen to the alcohol. He finds association, he asserts causation. Now he makes no attempt to measure any differences of race or environment in the two cases. He assumes them to be apparently of similar character. Yet when we remember that about 55 °/。 of the population of Helsingfors is of Swedish descent and 34 °/。 roughly Finnish, we think ourselves justified in asking that some statement as to the races investigated should be made. Weight of baby at birth is well known to be a racial character, and it is very unlikely that Swedes and Finns, and probably Russians, drink in the same proportions.

Laitinen states that the samples he has taken do not differ in the circumstances of the drinking and non-drinking groups. We can illustrate his measure of likeness of circumstances by his treatment of 59 drinking and 50 non-drinking families in a little country town, "where," he tells us, "the daily habits of the inhabitants are well known to everybody." The division here is merely between "abstainers" and "drinkers," and there is no evidence at all as to whether the drinking or conception came first, only "the daily habits of the inhabitants are well known to everybody."

The ages of the fathers and mothers show that they are not past the child-bearing age, hence to obtain a rough value we have deducted two years for each child from the present ages to reach age at marriage; this is rather considerable, but there are a certain number of miscarriages recorded, 1 °/ₒ for abstainers and 6 °/ₒ for drinkers.

	Gross size of Family	Age of Father	Age of Mother	No. of Rooms	Ages at Marriage	
					F.	M.
Abstainers ...	4·28	47·2	39·5	2·83	38·6	30·9
Drinkers......	4·72	40·3	39·0	2·31	30·9	29·6

The ages at marriage are at once seen to be extravagantly high for any test sample of the population. The greater fertility of the drinkers (here again there is no distinction drawn between cases in which alcohol is taken by one or both parents, a *sinê qua non* of any scientific inquiry!) is in agreement with our results. But we see a very marked differentiation again between the two classes, the father was only one year older than the mother in the case of drinkers, but *seven* years older in the case of abstainers; there was half a room, 25 °/ₒ difference, in the average house accommodation of the two classes. Again we say that until these points have been allowed for, it is impossible to say whether the differences observed in the defectiveness of the children are environmental or hereditary—exactly as they appear to be in Demme's selection of 10 drinking and 10 sober families. That the statistics refer to a degenerate or slum population, if we are to trust another of our critics, Professor Marshall, is evidenced by the drinkers only occupying 2·3 rooms and the abstainers 2·8*! Yet the men who make these criticisms against us do not hesitate to use Laitinen's results for their own propaganda.

We now turn to Laitinen's third series of observations. Here again there is no distinction between those cases in which one or both parents were abstainers or drinkers. The number of children was investigated, and the average number runs according to the category from four to five. No evidence whatever is given as to how this series of "3611 families with a great number of children" was obtained. They must have been observed over a period of some 10 or more years, because the *average* number of children is five and the weights of all the children are given as babies. There is no statement whatever bearing on the point of the drinking having begun before the birth of the first child, and there are several features which cast grave doubt on the results as tabled. Thus from his 2125 schedules of new-born children he finds for the weights of the boys of "moderates" and "drinkers" at birth 3780 and 3700 grammes respectively. But when he deals with 5845 instead of 2125 cases he obtains precisely the same figures to the last place, 3780 and 3700 again. To anyone acquainted with statistical results, that two means based on 2125 and 5845 cases should agree to four figures is rather astonishing. But other surprises await us. In dealing with

* The average number of rooms in Laitinen's first or schedule population are: abstainers 3·73, moderates 3·95, drinkers 3·70. This shows that his two series belong to wholly different social classes!

the 3611 cases in which he knows the history of *all* the children he mixes them up with the 2125 schedule children, and then says the number of children is misleading relative to the number of families. In other words he appears to have added 840 isolated children into the abstainers' children, 623 into the moderates', and 662 into the drunkards' children (see his Table II, p. 267, and statement on p. 264; the numbers in the third paragraph of p. 269 are erroneous). But he says if we subtract these results we shall find that the number of children in the respective families is nearly the same. We have done this as follows:

	Number of Families	Number of Children	Number of Children
Abstainers...	711	2855	4·01
Moderates ...	1210	6050	5·00
Drinkers ...	1799	8978	4·99

It will be seen that this does *not* make the number of children the same. As we also have shown in our memoir, the users of alcohol have more children. The total number is not 3611, but 3720, which indicates that Laitinen has added in the special 109 families of 50 abstainers and 59 drinkers, which contains no moderates and of which there is no evidence to show that the babies were weighed (see p. 265). But a graver point is: how was the mortality calculated? The schedule babies *must* have lived to eight months; there is no evidence that the author ever collected data later as to their mortality. If they are included in the living children, the mortalities calculated are wholly erroneous. Also the percentages of miscarriages given in the case of 5845 births, 2125 of which are cases of selected non-miscarriages, can only be fallacious. We have endeavoured by aid of the mean ages of mothers and fathers for the first and second series to deduce the mean ages of Laitinen's third series from his Table IV. We have obtained the following results:

	Mean Age of Mothers	Mean Age of Fathers	No. of Children	Ages at Marriage	
				M.	F.
Abstainers...	38·73	42·79	4·01	30·71	34·77
Moderates ...	34·90	41·11	5·00	24·90	31·11
Drinkers ...	36·25	41·58	4·99	26·27	31·60

Our probable age at marriage is calculated as before, allowing two years for each child. Perhaps more ought to be allowed because the ages of husband and wife at marriage, especially among the abstainers, are very high. No allowance has been made for this by Laitinen, and yet we see that the age of the mothers in the drinking groups is about five years less than the ages of those in the abstaining groups, while the age of the fathers is about three years less. It is quite certain that the age of the mother at least and probably the age of the father affects the well-being of the child, and that

the presence of many young mothers in the alcoholic group may influence the weight and general health of the child quite as much as the moderate drinking of the father. Until Laitinen's data are treated by more adequate statistical methods and allowance made for possible racial and parental age differences in the three groups, we cannot for a moment accept as final his conclusion that: "If we reflect upon the facts above mentioned, we find that all observations, whether made on a small or on a large scale point in the same direction, namely, that the alcohol drinking of parents, even in small quantities (about one glass of beer a day), has exercised a degenerative influence upon their offspring" (p. 269).

As for the facts themselves there is nothing which in the least refutes anything in our paper. We have noticed a differentiation in weight of an equally slight character, and a substantial difference in mortality. Only a person who has studied neither paper could assert that they do refute each other. But the statistical method of handling the facts and the sweeping and dogmatic conclusions drawn by Laitinen from them are unjustifiable. Laitinen's statistical method is often at fault; he has committed all the crimes of which we have been accused, but not convicted. And his populations have far more evidences of differentiation than ours exhibit. The high praise which Dr Saleeby* and Dr Johnston† bestow on this work is only evidence of their complete inability to weigh scientific investigations.

(4) *Bezzola's Memoir.* As a further exceedingly instructive illustration of the real value of the judgment of our medical critics we will take a paper by Bezzola‡. This paper, apart from a large amount of more or less irrelevant introductory talk, professes to examine a fairly simple statistical problem. The number of births in Switzerland, 934,619, for the years 1880—1890 are distributed in their respective months; then the births of 8,196 imbeciles are taken from a census issued in 1897 and dealing with the children who in the years 1880 to 1890 were incapable of going to school or of profiting by going to school. After omitting the epileptics, deaf-mutes, the blind, cripples and physically defectives, the moral degenerates, etc.—4287 in number, Bezzola distributes the remainder, 8196 (*Schwach- und Blödsinnige*), in the months of their birth. The statistical problem is then to ascertain whether this sample of 8196 differs in distribution significantly from the 934,619 total of all births. This total population Bezzola speaks of as the *normal* curve of distribution. It is of course the total birth population and contains the imbeciles as a contributory factor. Now here is a perfectly simple problem. We have to place those 934,619 individuals in 12 groups, and draw from this material a random sample of 8196 individuals. We have then to ask what will be the probable range of deviations

* He finds Laitinen's study "an admirable contrast in method (!) and manner" to our memoir (*British Journal of Inebriety*, Vol. VIII. p. 63).

† "Very different from it [our memoir, "discredited as a scientific pronouncement"] is the masterly work of Professor Taav Laitinen of Helsingfors" (*Alcohol, the Parent and the Child*, p. 18).

‡ Statistische Untersuchungen über die Rolle des Alkohols bei der Enstehung des originären Schwachsinns. *Bericht über den* VIII *Internationalen Congress gegen den Alkoholismus abgehalten in Wien* 14. *April* 1901, Leipzig u. Wien, 1902, S. 109—111. Almost verbatim also in *Internationale Monatsschrift zur Bekämpfung der Trinksitten*, 11. Jahrg. 1901, S. 171—183.

of any such random samples, and inquire where the actual sample of 8196 imbeciles exceeds these limits. Now does Bezzola attempt any scientific solution of this problem? Not in the least; he plots solely the *variations* in the monthly birth-rate of the whole population and of the imbeciles on a scale which hugely exaggerates the differences between the "normal" and the imbecile curves; and then whenever he finds a rather marked visible difference, he at once seeks about for some festival season nine months earlier to account for it on the prejudgment that alcohol at festivals is the source of imbecility in offspring. Not chronic alcoholism, be it noted, but acute alcoholism at the moment of conception.

In Diagram III we have endeavoured to reconstruct the data upon which Bezzola worked, distributing the 8196 imbeciles into their respective months. The polygon AA gives a "normal" population of 8196 individuals, *i.e.* the total 934,619 reduced to this total. On either side of this polygon we have set up twice the probable error, and obtained the belt bounded by CC and $C'C'$. Within that belt, on the average for each month, nine out of ten random samples would fall. Hence in taking *twelve* months, we should expect at least one point on the random sample curve to fall outside this belt on the theory of pure chance selection of 8196 individuals out of 934,619. This is exactly what occurs in Bezzola's data. The imbecile curve lies in 11 months entirely within the zone of twice the probable error and then drops outside in one month, just as it should do if it were a purely random sample. In other words there is not one grain of evidence in Bezzola's data for a statistical differentiation in the periods of the year in which imbeciles and the general "normal" population are born.

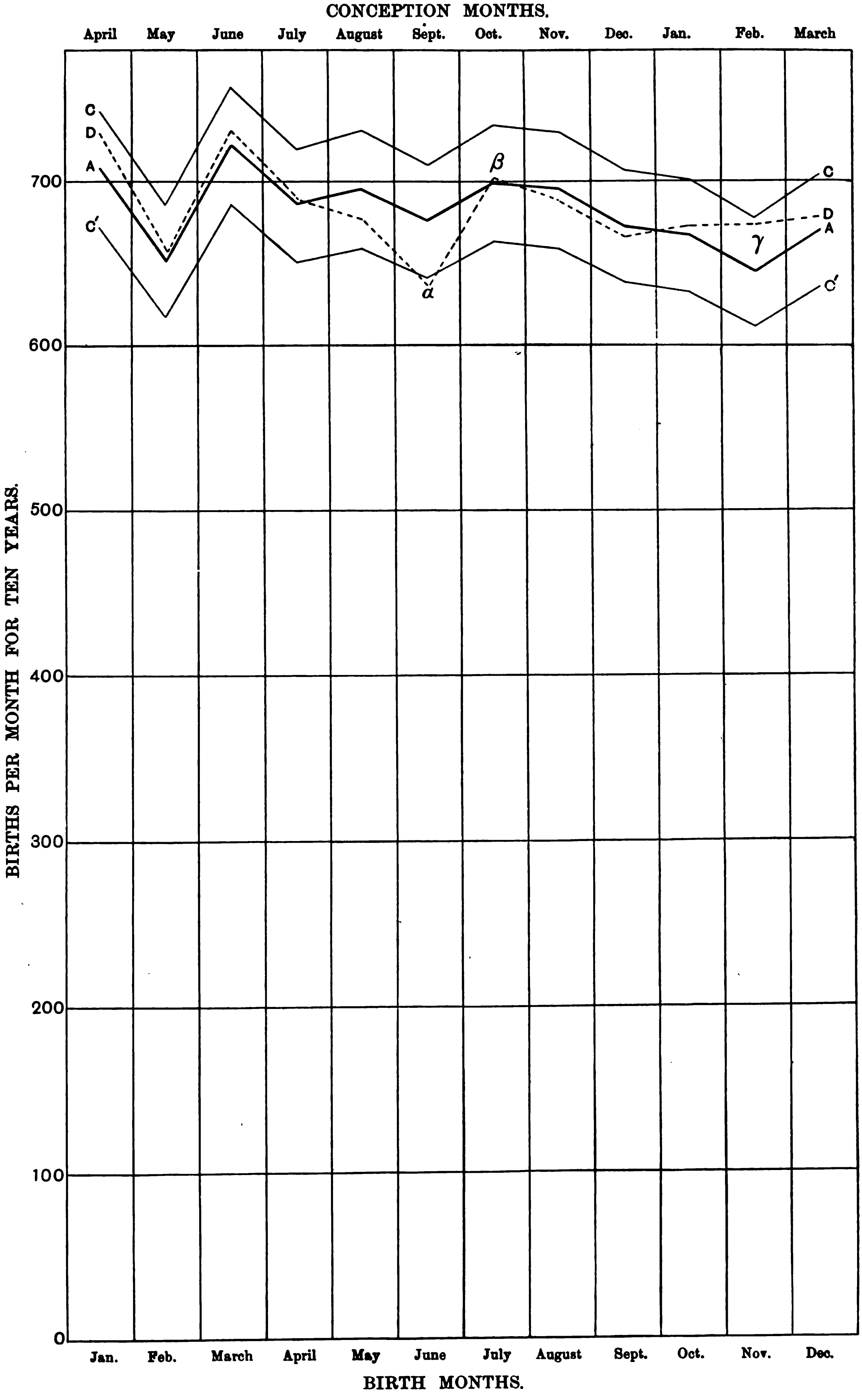
Now if the reader will fix his attention on the diagram he will see three points on the DD or imbecile curve marked α, β and γ. The excess at β of the dotted line over the continuous line represents *three* births due to the October conceptions* in a total of

* The language in which Bezzola describes this deviation of *three* imbeciles from the expected number is so very characteristic of the method of writing adopted by temperance medical writers, that we cite it at length, having premised that it is the fall in September—were it really significant—and not the normal number of births of imbeciles in October, which would need explanation.

"Aber im Oktober flackert es plötzlich wieder auf. Man hat sich zu neuen Excessen erholt und die Weinlese in manchen Gegenden sorgt für neues Keimgift. Ich betone, dass diese aus der Tiefe des Septemberstandes herauf plötzlich wieder aufsteigende Schwachsinns-Zeugungscurve zu einer ganz ungeahnten Höhe ansteigen würde, wenn die Schweiz nicht nur zum gerinsten Teil Weinland wäre. Ein Beweise dafür bietet der Kanton Waadt, wo in diesem Monat die Verhältnisszahl 112 erreicht wird und das Weinjahr 1885, dessen gesegneter Monat Oktober bewirkte, dass die tägliche Durchschnittszahl der Geburten Schwachsinniger im Juli 1886 die stattliche Nummer 209 annimmt, also mehr als das Doppelte des Tagesdurchschnitts des ganzen Jahres erreichte" (*loc. cit.* S. 182).

Bezzola tells us that the population—presumably the "Sommerfrischler"—have refreshed themselves for new excesses, and that the vintage in many districts provides for new poison, this to explain an absolutely non-significant addition of less than $0{\cdot}5\,{}^\circ/_\circ$ to the imbecile birth-rate calculated on the normal birth-rate for the month! He apparently sees the absurdity of this and informs us that this October excess (!) would reach an astonishing height if Switzerland were not to the smallest extent a wine country. He seems to forget that he has just told us that the height reached is due to the vintage in *many* districts! To demonstrate the effect of the vintage, which is absolutely imperceptible on his own statistics, and to provide a proof of his assertion Bezzola then proceeds to quote what appear gigantic numbers for the

DIAGRAM III.


CONCEPTION MONTHS.
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
March
BIRTHS PER MONTH FOR TEN YEARS.
700
600
500
400
300
200
100
0
C
D
A
C′
β
α
γ
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.
BIRTH MONTHS.

700. This is *absolutely without significancé*, but it is the "fact" on which the absurd talk about the influence of the vintage on the conception of imbeciles is based. At γ we have an excess of 31 births or a deviation of 4·8 per cent.; this deviation, as the diagram shows, lies well within the limits of a random sample, yet Bezzola associates it with drinking at the Shrove-tide festival in February*! Christmas and New Year festivals and the harvest festivals, to say nothing of Walpurgisnacht—a far more sexual festival than many others in many Teutonic districts—produce not even the slightest effect on the imbecile curve as distinct from the "normal" curve. But there is a drop greater than any other deviation among the conceptions of imbeciles in September. As we have already seen, *one* such deviation was to be expected. But not even our statistical tyros could overlook a difference of 40 births when they were emphasizing differences of 31 and of 3. How does Bezzola explain the drop in August

Canton Vaud. He says that in the October of the wine-year 1885 the *daily* average of imbecile conceptions reached 209, or more than double the daily average of the whole year. The unsuspecting layman at once supposes that 109 extra imbeciles per day were born in the Canton Vaud owing to the vintage of 1885! Of course Bezzola does not give his absolute numbers, or his argument would crumble in the stating of it. But we have enough data to get out something like his original numbers, and show the absurdity of his whole reasoning. 8196 imbeciles were born in ten years in Switzerland, or approximately 68·3 per month. The population of the Canton Vaud is ·085 of the whole population of Switzerland, thus Vaud must contribute 5·8 imbeciles per month to the births of imbeciles. Therefore all Bezzola means when he says that the *daily* average of imbecile conceptions rose from 100 to 209 in the October of the wine-year 1885 is that in the month in question 11 or 12 imbeciles instead of the average six were born, *i.e.* this vintage, if it contributed anything at all, contributed not 109 imbeciles per day but a total addition of six during the vintage. But he never stays to ask whether this number has any real significance. The actual problem to be answered is this: If on an average 5·8 imbeciles per month are born, what is the chance that in ten years, *i.e.* 120 trials, we shall find a month with 12 imbecile births? The number of births in the Canton Vaud for the period in question must have been about 662 per month of each year, or the chance of an imbecile birth about $\frac{1}{114}$. Accordingly the distribution of random samples of imbecile births follows the binomial $(\frac{113}{114} + \frac{1}{114})^{662}$. The first 20 terms only are significant in at least the fifth decimal place, and the chance of 12 or more imbeciles being conceived in one month is ·01564. In other words on the theory of random sampling we should anticipate that this excess of idiots would occur twice in the 120 months considered by Bezzola for the Canton Vaud! Bezzola found it *once*; there is nothing whatever of significance in that on the numbers cited. Add to this that had a like excess of imbecile conceptions occurred in December, it would have been put down to "Weihnacht," if in January to "Neujahrzeit," if in February to "Fastnachtzeit," if in April to "Maibowlen" at Easter, if in May or June to "Hochzeitsfesten," and so forth,—and we see how hopelessly absurd is this sort of reasoning. Yet such stuff, without any scientific value, is acclaimed by Dr Saleeby, Sir Victor Horsley and Dr Basil Price as worthy of credence, and Senator and Kaminer actually speak of it as a proof of a "characteristic and indisputable" kind that acute intoxication has an immediate toxic effect on the germ-cell! There is not the least evidence direct or indirect to show that the parents of the half-dozen extra imbeciles who were conceived during the month of October, 1885, in the Canton Vaud were ever acutely intoxicated in their lives, or were in 1885 or any other year even engaged in vintage operations. Select a big enough scale, however, and talk about a *daily* average of 100 imbecile conceptions being raised to 209 instead of giving the actual numbers of extra imbecile conceptions as half a dozen in the whole month, and this simple artifice of multiplying by 500 will succeed in impressing those members of the unscientific public who like voracious puppies swallow all they come across without nosing it.

* If it were significant, which it is *not*, it would be more reasonable to associate it with the possibility that mentally defective women were more likely to become mothers and therefore to produce defective children at these periods than to associate it with the alcohol drunk.

and September? "Die gesunde Arbeit der Landbevölkerung einerseits und die vernunftgemässe Lebensweise der Sommerfrischler lässt für Alkoholexcesse wenig Raum, auch sind die Festlichkeiten rarer geworden und die Vereinsmeierei macht Ferien."

Had August and September been months of excess of imbecile conceptions instead of defect, no doubt stress would have been laid on the *Aerntegebräuche*, on *Maria Geburt* and *Maria Himmelfahrt*. Those who know the habits of the Teutonic peasantry well, and one of us has spent many months among them, know that alcohol on these occasions is consumed with a vigour as great, and that the festivities are as widespread, as at the vintage, which touches a far smaller range of the population. Meanwhile the "vernunftgemässe Lebensweise der Sommerfrischler" is an exquisite idea to account for a purely random drop in the number of imbeciles conceived in September. Had May shown a marked excess (it is actually as much in excess as the vintage month!) no doubt the trouble would have been attributed to the *Pfingst* drinking! Even the *Sommerfrischler* are too much for Leppmann, who states that Bezzola's results showed in July, August and September a "retrogression which affected principally the imbeciles-chart (plenty of work and few holidays)*." In other words, one of these doughty champions of degeneracy following even temporary consumption of alcohol finds that holidays diminish in the August and September period and argues for fewer imbeciles, the other attributes directly to the holidays being then in season the absence of imbeciles. Neither explanation is of any importance, as we have already indicated.

Now let us see what our own critics have to say about Bezzola. First and foremost for rashly accepting results without weighing them must always be taken, Dr Saleeby. This is what he writes (*The Eugenics Review*, Vol. II. p. 41): "Reference must also be made to the well-known work of Bezzola, which may be most conveniently (!) quoted from Forel as follows":

"'The recent researches of Bezzola seem to prove that the old belief in the bad quality of children conceived during drunkenness is not without foundation. Relying on the Swiss census of 1900, in which there figure nine thousand idiots, and after careful examination of the bulletins concerning them, this author has proved that there are two acute annual maximum periods for the conception of idiots (calculated from nine months before birth). In the wine-growing districts the maximum conception of idiots at the time of the vintage is enormous, while it is almost *nil* at other periods. Moreover, these two maximum periods come at the time of year when conception is at a minimum among the rest of the population; the maximum of normal conceptions occurring at the beginning of summer.'"

Forel then goes on upon the basis of this slender evidence to talk about the germ-cell leaving its gland at the moment when it is impregnated with alcohol and the resulting individual developing all kinds of taints and defects. This may or may not be true; all we can say is that the imbecile births diagram provides no evidence whatever for the state of affairs described. Let the reader fix his eyes on the points β and γ of our chart, and consider whether the deviations from the normal justify

* Leppmann in Senator and Kaminer's *Health and Disease in Relation to Marriage*, Vol. III. p. 1092.

a single line of Forel's statement. It is only reasonable to suppose that Dr Saleeby has never seen Bezzola's "well-known work" which he finds "most conveniently quoted from Forel." Had he done so he would have known that (i) the data were not taken from the Swiss census of 1900, (ii) there were nearer eight than nine thousand imbeciles, (iii) there are not two *acute* annual maximum periods for the conception of idiots, (iv) there is no evidence for the conception of idiots at the time of the vintage being enormous and almost *nil* at other periods in either the wine-growing districts or any others*, (v) the two periods of maximum conception of idiots do not coincide with the times of the year when conception is at a minimum in the rest of the population. In fact no statement made by Forel in the extract cited by Dr Saleeby is correct†. But we have not done with Dr Saleeby yet! In his paper in the *British Journal of Inebriety*, Vol. VIII. p. 59, he tells us: "We have Bezzola's inquiry showing that in Switzerland most idiots are conceived at the time of the vintage." Will the reader again fix his attention on our diagram and note how the excess of *three* idiots, lying in itself well within the limits of random sampling (see the point β and carry the eye to the bottom of our diagram!), has now been magnified into "most idiots"?

Dr Basil Price—honorary treasurer of a society which professes to *study* inebriety—finds the memoir of the present writers "effectively criticized" by an author who can make such statements as we have just cited above. He himself contributes to the humour of the situation the following paragraph (*British Journal of Inebriety*, Vol. VIII. p. 73):

"In certain wine-growing districts of Austria it has been shown that the majority of imbeciles are conceived during the periods when most drinking takes place."

Here we have a perfectly definite statement as to a *majority of imbeciles being conceived*, although it is delightfully vague as to what the periods in question are. This paragraph has been taken as confirming Bezzola's results (?) as to the vintage. On what is it based? Dr Basil Price merely cites Leppmann in Senator and Kaminer *without reference to a page*. The only passage we can find bearing on the subject in Leppmann's paper occurs on page 1092, and runs: "At the discussion on this interesting communication (*i.e.* Bezzola's) at the Vienna Congress against alcoholism, a medical man said that the teachers in wine-growing districts of Lower Austria know that a material of very bad scholars in any one year denotes a good vintage 6 years previously."

This statement made by a nameless man‡ as to the opinion of teachers as to

* The argument as to the vintage would be almost exactly parallelled if September were shown to be a month with an excess of imbecile births in Kent, and it was then attributed to beer, because it was the month of the hop-harvest. Are the "Weinleser" supposed to consume the grapes or the must?

† Yet Dr Saleeby writes: "The well-known research of Bezzola...was based upon an enormous number of cases derived from official statistics. The evidence has been studied and accepted by such a careful critic as Professor Forel, and the precise data for which Dr Ryle asks [evidence of the results of conception during acute alcoholism], as if we had them not, are the very data the careful analysis of which led Bezzola to his conclusion" (*National Temperance Quarterly*, Sept. 1910, p. 170).

‡ It is actually quoted again as scientific evidence by Sir Victor Horsley (*Alcohol and the Human Body*, p. 326).

bad scholars for the whole of one year—an absolutely worthless statement for any scientific purpose, with not a number in it nor a measure of "bad" and "good"—is directly modified by Dr Price into an assertion that *it has been shown, i.e.* demonstrated, that a *majority* of *imbeciles* are conceived in Austrian wine-growing districts during the periods when most drinking takes place! Can any better proof be given that the foremost medical champions of degeneracy as a product of alcohol in the parent at the time of conception are entirely untrustworthy as critics and as men of science? But there is a more serious aspect to the whole matter. The *British Journal of Inebriety* is the organ of the Society for the Study of Inebriety, and on the first page of this *Journal* is a list of the vice-presidents of this society. It includes among other well-known names those of Sir Clifford Allbutt, Professor William Osler, Dr F. W. Mott and Dr R. Welsh Branthwaite, men who certainly weigh their arguments before they speak. Have these leaders of medical thought any idea of the gross absurdities to which they, unconsciously perhaps, but none the less effectively, are giving currency by the appearance of their names in this *Journal*? We had no desire whatever to examine the literature of this subject *before* starting our own investigation; we determined to come unprejudiced to an examination of the problem on unbiased data. This we accomplished, and we published our results indicating that the consumption of alcohol in the parent did not produce any *marked* mental or physical degeneracy in the offspring of school age. We have been assailed by a perfect army of critics—largely furnished with old-fashioned blunderbusses—who apparently confuse the whole alcohol problem with the problem of the influence of parental drinking on the mentality and physique of the offspring. They sympathise with Laitinen when he asserts that one glass of beer a day exercises a degenerative influence on the offspring or with Bezzola when he anticipates that: "Man wird vielleicht einmal zur Einsicht gelangen, dass jeder Tropfen Alkohol beim Erzeuger einen Tropfen Dummheit bei Erzeugten bedeutet' (*Internationale Monatsschrift zur Bekämpfung der Trinksitten*, 1901, p. 183).

These extreme views may or may not be ultimately demonstrated to be correct. We are quite certain that at present there is no definite evidence at all in their favour. We are now also fairly convinced that evidence collected by such critics as we have referred to will never be treated by any scientific method that we could trust, and that we should further have to ask overwhelming proof of the unbiased nature of its origin. We believe we have sufficiently illustrated in our sample of three stock temperance medical memoirs how wholly lacking these writers are in critical instinct; any processes or any data are sufficient, if they can be made to support a preconceived opinion*. Such authors can on one page speak of the "thorough

* Thus Sir Victor Horsley tells us that we have wholly neglected "Galton's well-known law that the contribution of the parents to the physique and mentality of a child is about one-half of the whole, that of the grandparents one-eighth, and so on. When one parent only is considered (see memoir) this gives us only one-fourth of the total hereditary forces at work, and consequently no conclusions whatever ought to have been drawn" (*National Temperance Quarterly*, Sept. 1910, p. 181). Now Sir Victor Horsley is one of the persons who assert that alcohol produces a toxic effect on the germ and so on the offspring. What has this to do with Galton's law, which, whether true or not, was stated by its author as

investigation" of Dr MacNicholl, and the next page state that the absence of any inquiry as to the "habits of the parents *previous* to and *during* conception of the children" quite vitiates any value in a report (Dr Basil Price, *N. T. Q. loc. cit.*, pp. 176—7). Such authors can in one breath tell us that although we cannot for obvious reasons find out the exact condition of the parents at the conception it is possible to find out "their habits of life," and yet in the next assert that the "habits of life" are not sufficient but that we require knowledge of three or four generations of the stock! In short everywhere logical confusion, chaos and misstatement.

One remarkable point remains to be noticed. In April 1901 a Report was presented to the "Society for the Study of Inebriety" by their Committee on Heredity consisting of nine medical men. This Committee state that:

"They are aware of and have devoted full consideration to the widespread belief that parental indulgence tends to render the offspring more innately prone than they otherwise would have been to excessive indulgence, but they can only reiterate their conviction that the existing evidence on the subject does not at present warrant such a conclusion" (Art. XIV). And again:

"In particular there is no evidence that characters acquired by the parent through indulgence in drink are inherited by the children subsequently born. The committee are aware that it is possible that the mental and physical states produced

applying to an inherent, not acquired, germinal character? The answer to this question is at once found by examining Sir Victor Horsley's book on *Alcohol and the Human Body*. He does not know what heredity means in any modern scientific sense. He speaks of "the appalling force of hereditary influence" when he is referring indifferently to the toxic effect of alcohol on the germ, or to an inherent character of the germ-plasm of a given stock. When Dr Crothers says that in reporting 1744 cases of inebriety he found 1080 with a distinct history of heredity, it never appears to occur to Sir Victor that the case may not be the same as that of alcoholised hens' eggs or the puppies of alcoholised dogs or guinea-pigs. Fancy a modern scientist talking about the manner in which "the appalling force of hereditary influence may be mitigated!" The only manner in which you can mitigate heredity is to cease to breed from bad stock, and no toxic effect of either alcohol or syphilis has anything to do with true heredity. As for Sir Victor Horsley's statement that no conclusions whatever ought to have been drawn from our memoir "because when one parent only is considered only one-fourth of the total hereditary forces are at work," the reply is obvious that if one-fourth produces zero effect, four times one-fourth will also produce zero effect. The application of the law to such a case, however, is wholly meaningless. Sir Victor Horsley's final conclusion is one of the most sweeping that we have yet come across! "The fact is there is only one way in which this question can be properly studied, and that is by obtaining data from some source which can provide instances of genuinely abstaining families for three or four generations. These should be compared with people in similar circumstances of life, amongst whom it can be proved that drinking habits have prevailed for the same period" (*loc. cit.* p. 181). Excellent doctrine! We need data covering 75 years or a century of families remaining in the same circumstances. But until that material is forthcoming, why does Sir Victor Horsley write a book on *Alcohol and the Human Body*, why does he write a chapter on Parental Alcoholism, why does he open it with a quotation that "Hereditary alcoholism is an undeniable fact," and why, above all, does he cite Laitinen, MacNicholl, Crothers and Bunge, who have wholly failed to comply with the "only" way "in which the question can be properly studied" as authorities worthy of consideration in the matter? There is only one answer to these questions. This criticism was not part of his intellectual stock-in-trade, or he would have applied it *ab initio* to these investigations. He ran up against it as a sort of weapon which might possibly fit the case when he found facts not in accordance with his own preconceived opinions.

in the parent by indulgence in alcohol do affect the child in some way through inheritance; again, they admit as possible, though strictly speaking this is no question of the inheritance of an acquirement, that indulgence may so damage the parental tissues that the germ is ill-nourished and the child is thus affected; yet again they admit as possible that the alcohol circulating in the parents' blood may directly affect the germ and in this manner affect the offspring as by producing degeneracy. *But these speculations have not been strongly supported by any evidence tendered to the Committee*" (Art. VI).

The words we have italicised hold as truly in 1910 as in 1901, there is no strong support in any evidence yet produced for these speculations. Yet when we come to the same conclusions as the Committee on Heredity of the Society for the Study of Inebriety, on the basis of quite independent and unbiased material, the *Journal* of that Society has not invective enough at its disposal to describe our "mischievous and indefensible contribution to the printed folly of nations." To such rhetoric we can but reply in the words of the old song:

> Pray, Goody, please to moderate the rancour of your tongue,
> Why flash those sparks of fury from your eyes?
> Remember when the judgment's weak, the prejudice is strong.

(5) *Demme's Contribution to the Subject.* We will now pass to a last illustration of the manner in which our medical critics deal with statistics and the amount of care they give to their critical examination. We will consider the results of Demme. Horsley quotes Demme from Hodge, Basil Price quotes him from Kirby who again quotes him without any reference to the original at all (*British Journal of Inebriety*, Vol. VI. p. 166). The tables given by Horsley and Basil Price are not in agreement. With such a method of quoting authorities can we wonder if the title "scientific" be denied to papers published by these temperance writers? It almost compels one to believe that they have not themselves studied, and do not want others to study, the originals from which their data profess to be drawn. We shall content ourselves by criticising the data of Demme as they are actually cited without comment or warning by Sir Victor Horsley and Dr Basil Price.

The following is the record of the children of 10 drunkards and 10 sober pairs of parents prepared by Professor Demme and provided by Dr Basil Price:

Children of Sober Parents	Totals	Children of Drunkards	Totals
Entirely normal	50	Entirely normal	9
Mentally feeble, by no means idiotic ...	2	Idiots	8
Died of general weakness...	3	Had epileptic or convulsive fits	13
Died of gastric catarrh	2	Became drunkards, with complication of epilepsy and chorea	5
Had chorea	2	Deaf mutes	2
Physical deformity	2	Physical deformity	3
		Dwarfs	5
		Died in early infancy	12
Total	61	Total	57

Now either these 10 cases of sobriety and 10 cases of inebriety are typical of the whole population of sober and drunken parents or they are not. If they are *selected* cases then Sir Victor Horsley and Dr Basil Price have no logic whatever when they cite them as exhibiting the influence of alcohol in the parent. We must start therefore with the assumption that they represent the average results of sobriety and inebriety*. Let us see whither it leads us. The percentage of drinking parents in Switzerland must be at least 30 °/₀. This is, as the American and English returns show, quite an average percentage, and Professor Demme himself tells us that 10 °/₀ of the population of Berne *die* of alcoholism. (For Switzerland 10·5 °/₀ of men from 20 to 40 years of age and 15·5 °/₀ of men from 40 to 60 years are said directly or indirectly to have died of drink in the 15 greater towns between 1891 and 1899 †.) We can now reconstruct our total population of which our 10 sober people and 10 drunken people are supposed to be random samples. These random samples of parents would produce offspring in the proportions given in the table below. Now is this not another striking instance of the manner in which these gentlemen in the name of science thrust statistics on the untrained public without having the inclination or capacity to *weigh* them as well as cite them? In the first place we have an infantile death-rate which is wholly out of keeping with any vital statistics with which we are familiar. In the next place the drunkards have practically died out in the next generation, from some percentage like 30 they have dwindled to 2·5 °/₀! And if it be argued that we have taken too high a percentage of drunkards for Demme's district, then be it noted these results will be not bettered, but rendered far more anomalous! Make your drunkards only 10 °/₀ of the population—an obvious under-estimate, because Demme tells us that 10 °/₀ *die* of alcoholism,

Reconstructed Population according to Demme's Samples.

Normal Individuals	63·0 °/₀
Deaths in Infancy...	11·9 °/₀
Idiots and Mentally Feeble	6·4 °/₀
Epileptic	6·5 °/₀
Epileptic Drunkards	2·5 °/₀
Deaf-Mutes	1·0 °/₀
Cases of Chorea	2·3 °/₀
Dwarfs	2·5 °/₀
Physically Deformed	3·8 °/₀
Total	99·9 °/₀

* This is a very big assumption, as any statistician would have informed these gentlemen. The probable errors of the results based upon these numbers are enormous. For example, the probable error of 2 deaf-mutes occurring in 57 persons is ·94, thus the real number of deaf-mutes might easily have been either 0 or 4; for 5 dwarfs in 57 it is 1·5, so that the number of dwarfs might have been easily either 2 or 8. Beyond this, however, we know that deaf-mutism and dwarfism run in families, so that these probable errors ought not to be based even on 57 units!

† *Archiv für Rassen- und Gesellschafts-Biologie*, Bd. I. S. 238. Dr Basil Price (*British Journal of Inebriety*, Vol. VIII. p. 77) asserts that on the most conservative estimate the alcoholic *death-rate* in England and Wales is 14 °/₀; this can hardly denote less than 30 °/₀ who drink considerably.

and this must mean a far higher percentage of living alcoholists—and we find an infantile death-rate of 9·4 °/₀ and a percentage of drunkards in the offspring population of 0·8 °/₀. We need to raise, not lower, our percentage of drinkers to make Demme's numbers agree with well-tested returns for infantile mortality. But let us look further. According to Demme's results the drunkards would practically die out in one generation. Their numbers would sink from 30 °/₀ to 2·5 °/₀, or from 10 °/₀ to 0·8 °/₀ according to the hypothesis made as to the proportion of sober parents. Why, on Demme's figures drunkenness would practically cure itself in one generation, for the sober contribute nothing to the next generation of drunkards and the drunken parents only one-twelfth of their own numbers! This solution of the drink problem has never apparently occurred to Sir Victor Horsley, Dr Basil Price, or Dr Saleeby, when they cite such data as representing the average effects of sobriety and inebriety. What is absolutely necessary on the basis of Demme's figures, unless the sober are reduced to less than a moiety of the population, is that a large number of the normal offspring of the sober parents should become drunkards; there are not enough offspring left of the drinking parents to keep up the supply of drunkards. If the retort be made that the normal offspring of the sober were judged *as children*, then the whole card-house falls to the ground for Demme has entered "drunkards" in the offspring of the inebriate, but not of the sober—the two classes cease to be comparable. But what would happen if Demme reduced his sober parents to less than a moiety of the population? Why the numbers of physically and mentally defective in his sample—already preposterous to any one acquainted with the statistics of the subject—would become so obviously absurd that not even a temperance advocate would venture to cite them. Look at them as they stand. We have here a population with 9 °/₀ of epileptics, with more than 2·3 °/₀ of cases of chorea*, with 6·4 °/₀ of idiots and mentally defective, with 1 °/₀ of deaf-mutes and 2·5 °/₀ of dwarfs.

In the general population epilepsy averages below 0·5 °/₀ (0·03 °/₀ in Switzerland), imbecility and mental defect below 2 °/₀, the prevalence of deaf-mutism is ·07 °/₀ in Europe (0·1 °/₀ in Switzerland), and as for "dwarfs," can Dr Basil Price or Sir Victor Horsley have any idea when they cite such statistics of the prevalence of either achondroplasia or of true dwarfism? 30 °/₀ of such a population as the above would be in special schools, asylums or reformatories. It is quite safe to assert that at a maximum not 5 °/₀ of any European population is under these conditions.

(6) *Mental Defect and Extreme Alcoholism.* Do we then accuse Professor Demme of manipulating his statistics? Not in the least. We can more than parallel them from the pedigrees of robust and degenerate families in the possession of the Eugenics Laboratory†. We assert that on the face of it such cases are

* Some of the epileptic drunkards suffered from chorea.

† Quite similar groups of families are given by MacNicholl (*Journal of the American Medical Association*, Vol. 48, p. 398, 1907), who states that of 102 children in 25 families of heavy-drinking parents, seven had tuberculosis, eight had disease of the heart, 31 functional diseases of the nervous system, 41 were drinkers, six were degenerates and four were idiots; only five of the entire number were

demonstrably not *random* or average data concerning the offspring of sober and drinking parents respectively. Epilepsy, mental defect, deaf-mutism and dwarfism, when this term is used in any proper sense, are hereditary characters. But as our material increases it becomes more and more evident that there is a link between these various physical and mental defects; they occur more often in association than is reasonable on any basis of probability. Superficially and for the time being only we may possibly look upon it as the inheritance of some defect in a general development-controlling determinant. The idea of stocks exhibiting "general degeneracy" is not an idle one, if by general degeneracy we refer to the correlated appearance of improbable mental and physical defects in a group of blood relations. It is easy to obtain pedigrees of such stocks when the material to be drawn from is sufficiently large or itself perhaps already selected as in special schools, hospital practice and inebriate reformatories. In such stocks mental defect is almost always one of the correlated conditions, and where mental defect occurs there cases of extreme alcoholism also occur. In a paper shortly to be issued by this Laboratory, it will be indicated that the mental defect to be found associated with the *extreme* cases of alcoholism antedates the alcoholism, and is the antecedent not the consequent of it. Where there is mental defect, say in about 1 °/₀ of the population, there in adult life alcoholism, prostitution and crime almost invariably follow. But because mental defect is an antecedent of extreme cases of alcoholism, and the children of such alcoholists show mental defect and other correlated abnormalities, it is purely idle to speak of parental alcoholism as the source of defect in the children. Mental defect exists in about 1 °/₀ of the population, 20 °/₀ to 40 °/₀ of parents, according to the locality and occupation, drink. A large percentage of those parents is by *inheritance* neither physically nor mentally inferior; as our Edinburgh data appear to show, they may be rather above the sober average. Judged by asylum and reformatory data, judged by special pedigrees such as we possess or Demme cites, there is a close association between alcoholism in parent and mental defect in the offspring. Judged by a general sample of the population this relationship is not evident. The explanation is a perfectly simple one; the individuals with hereditary mental and physical defect drift into extreme alcoholism, and pass into asylum and reformatory; it is their hereditary characters which produce not only the alcoholism, but the defective offspring. From this *association* of alcoholism, insanity and defective offspring, a confusion has arisen in the minds of many between association and causation. They have not troubled to investigate whether or no

normal. As Dr E. S. Talbot ("Alcohol in its Relation to Degeneracy," *Journal of the American Medical Association*, Vol. 48, p. 399) says, that excess in alcohol frequently occurs in degenerate stocks is undeniable. The discrepancies, however, between such statistics and others are great. "Lack of analytic skill and that dangerous, canting philanthropic tendency which rebels at statistics unfavourable to preconceived sociologic theories explain these discrepancies. The ignoring of all but the alcoholic factor produces also great elements of error. Kurnam (*Detroit Lancet*, Sept. 1882) cites 23 cases in which degenerate stocks were charged to alcoholic parentage, but which on analysis proved due to a degenerative factor in the parents of which alcoholism was merely an expression."

the mental defect antedated the alcoholism. The confusion at this point is so great that we must spend some time in driving the matter home. It is perfectly idle to quote statistics of the number of the insane or of imbeciles who have drinking parents, if at the same time the numbers of normal individuals who have drinking parents are not cited. It is usually assumed that if drinking parents are discovered in 20 °/$_{o}$ to 30 °/$_{o}$ of cases of insanity that this is evidence of parental alcoholism producing insanity in the offspring. Here is a statement from Dr Johnston, truly characteristic of this line of argument (*Alcohol, the Parent and the Child*, p. 11): "We have a body of authoritative evidence to show that a considerable proportion of imbecility and insanity must also be laid to its charge. The alcoholic taint was found by Dr Kerlin in 38 per cent. of all the cases in the Pennsylvania Institute for Imbeciles. Dr Shuttleworth puts the figure at 13·2 per cent. out of 1200 cases in the Royal Albert Asylum, and Dr Fletcher Beach at 19·5—21·4, if grandparents be included—out of 1180 cases at the Darenth Schools for Imbecile Children; while Dr Clouston says that 'from 18 to 20 per cent. of all cases of mental disease, wholly or in part in both sexes may be put down to alcohol as a cause (*Clinical Lectures on Mental Disease*, 1904).'"

Now just place the data of Dr MacNicholl cited by Dr Johnston himself against the American data of Dr Kerlin:

Percentages of Alcoholic Parents.

MacNicholl (Family histories of 3711 children) General Population		Kerlin Imbeciles	
Drinking Parents	73 °/$_{o}$	Alcoholic Taint	38 °/$_{o}$
Drinking Parents and Grandparents ...	68 °/$_{o}$		

That is to say the only authority quoted by Dr Johnston from whose writings we could test the value of his statement as to the effect of "alcoholic taint" on offspring shows almost *twice* the amount of alcoholic taint in the general population that we find among the population of imbeciles. It may be said that Dr MacNicholl's and Dr Kerlin's standards were not the same, but Dr Kerlin's data are of no service whatever to prove Dr Johnston's points until he has provided the only comparative data by which the matter could be judged.

Next take the Royal Albert Asylum data. Dr Johnston gives no comparative data in this case at all. We will, however, provide them:

Lancashire Manufacturing Town	Shuttleworth
Parents of children born in one year: "Notorious" drinkers 16 °/$_{o}$	Imbeciles (Lancashire) Alcoholic Taint 13·2 °/$_{o}$

What is the value of Dr Johnston's 13·2 °/$_{o}$ without any comparative data?

The values given for the Darenth schools are wholly idle for Dr Johnston's purposes. So is most of the material from the lunatic asylums, which attributes 20 °/$_{o}$—30 °/$_{o}$ of the insane cases to alcoholism as a primary or secondary cause. In the class from which public asylums and these schools draw their material

at a minimum 20 % and a maximum 40 % of the males in either generation, parent or offspring, use more alcohol than is good for them. The mere association of alcoholism with insanity either directly or through the parent to the extent of 30 % of the cases is no evidence at all even of a special association, still less of a causation. The statements made by Sir Victor Horsley and Dr Johnston may in the sequel prove to be either true or false; what is quite certain is that the evidence they bring to demonstrate these statements is wholly valueless as it stands.

We will take one more illustration of this, namely from Sir Victor Horsley. He extracts a pedigree of insanity from a paper by Dr Mott (*British Medical Journal*, Oct. 28, 1905). The family consisted of three sons and five daughters. Of these, two sons and three daughters, most of them more than once, had been in asylums. Of the mother we are simply told "no history of insanity in family." Of the father "No family history of insanity, fits or nervous disease. Chronic drunkard from boyhood." He had been twice in an asylum. "Facts like these can only be explained," writes Sir Victor Horsley, "by admitting that the condition of the health of the father has a marked influence on that of his offspring" (*Alcohol and the Human Body*, p. 316).

Now we have had experience of very large numbers of pedigrees in the Eugenics Laboratory, and especially of the difficulties of ascertaining facts with regard to the class of people who go into public asylums. The first question we naturally ask is: Who gave the information about the ancestry of a man who was born in 1830? Has this "chronic drunkard from boyhood" been trusted to state what his parents and grandparents, his uncles and his aunts and his cousins suffered or died from? It is the most difficult thing to prove a *negative* in a case like this—yet "no family history of insanity, fits or nervous disease" is dogmatically stated by Sir Victor Horsley. Can he ever have studied family history in pedigree form? If he has, he would have learnt to distrust every pedigree which asserts negative heredity, and does not give *detailed* information as to the members of the ancestry. We have pedigrees of special defects which for five or six generations show no case of the defect, but coming across the same peculiar defect in other stocks we have been able to link them up to a common ancestor. No student of heredity, we feel certain, would accept a pedigree which simply states at the *parental* generation "no family history," and gives no details of collaterals or ancestry, and would argue upon it as evidence of a general principle that the alcoholism of the father had produced insanity in himself and the children. The facts that insanity existed in both generations, and that the father was a "chronic drunkard from *boyhood*," point to other factors which destroy any validity in the argument. Even Sir Victor Horsley gives away his own case for he admits: "Possibly there may have been a strain of initial mental defect in the father, which when transmitted, was increased by the poisonous action of the alcohol."

"Possibly" indeed! But where is the evidence that the strain of initial mental

defect was not sufficient without the "poisonous action of the alcohol" to produce the observed results? Alcohol produces insanity, therefore it is poisonous, but insanity being there it must be a product of the "poisonous alcohol": such is the vicious circle in which minds which rush to premature judgments move and have their being.

We are glad to notice that Dr Clouston, in his recent evidence before the Royal Commission on Divorce, is reaching what we think is daylight on this vital alcoholic problem. He is reported to have said:

"As to the number of the insane who might be said to have brought on their disease by their own acts, conduct and course of life, he said that at one time he made a careful inquiry on this point, and his conclusion was that in not more than one-third of all the persons who became insane could the disease be attributed to their own acts or course of life. Excess in use of alcohol, the syphilitic poison, and dissipated courses of life he found were the three chief causes, but there was an evident fallacy in coming to any certain conclusion on this important question. It consisted in this, that the mental heredity was so much stronger in some cases than others, that there were many people in whose cases a very little alcohol or dissipation would upset their mental working, and in many of them it was certain that if such causes had not been brought into operation in their youth they would have become insane all the same as the time went on" (*Times*, October 26, 1910, p. 4).

At the back of extreme alcoholic and sexual excess will be found almost invariably a want of will-power, of self-control, that is, a mental defect. At a maximum 5°/₀ of the population may be estimated to have been at one time or another certifiably insane. Dr Clouston's third of the insane who have brought insanity on themselves by their own acts is not very largely in excess of the known mentally defective persons in the community. What becomes of the 1°/₀ to 2°/₀ of mentally defective children in adult life? Are they or are they not the same mentally defective persons as we find in prisons, inebriate reformatories and asylums for the insane? If not, we ask again, what becomes of the bulk of them? If they are, then how idle must be the suggestion that alcohol *per se* produces mental defect, prostitution and crime. Until we know whether mental defect is the antecedent or consequent of extreme alcoholism, it is purely idle to heap up examples of the association of extreme alcoholism with defectiveness in the offspring. If mental defect be the antecedent and not the consequent, then because it is hereditary, it will always be possible to pick out defective offspring in some extreme cases of alcoholism. But this admitted association is no argument at all that alcohol in all forms leads to degenerate offspring. Put in the shape of a syllogism we state: Mentally defective parents have mentally defective offspring. Mentally defective persons are especially prone to alcoholism. Both these statements can be demonstrated, but the inference drawn by our critics that all indulgence in alcohol leads to mentally defective children is not legitimate, and is at present unproven. Yet it is precisely this inference which Sir Victor Horsley and his colleagues draw from such statements as those of Demme, Kerlin and Shuttleworth.

Nay, some recognised authorities go further. Professor Dr Ploetz—a man for whom we have a great personal regard—sees that Demme has really selected his material and taken extreme cases of good stock and bad stock, yet he goes on to say that between these extremes come the great population, who have control over themselves and make a moderate use of alcohol. He proceeds to argue that, if extreme alcoholism produces such effects, since all things are continuous in their effects lesser grades of alcoholism must also produce their proportionate quantum of defectiveness in the children*. He does not see that it is necessary first to demonstrate that the alcoholism is the antecedent and not the consequent of hereditary defectiveness in these extreme cases. There lies the problem of inebriety in its most fundamental phase†. And if that problem be answered in the way we believe it will be answered, namely, that there is an antecedent hereditary defectiveness in those cases where parental alcoholism has been found associated with mental and physical defectiveness in the offspring, on whose shoulders will the blame lie for the partial shipwreck of the temperance movement? Will it not certainly lie on the shoulders of the men who are forming premature judgments on great social problems without studying the weight of the evidence they deduce; who thrust on the public as proof data which are self-contradictory, and must sooner or later be admitted as such? The only way to produce lasting reform in social matters is to speak the truth and nothing but the truth to the man in the street. We doubt whether the public have been told the truth in this matter; they have been told what the supporters of the temperance movement honestly *believe*, but the moment the writings of these men are studied it will be seen that the fundamental problems have not yet been answered, and if answered in a sense different from the current belief, the whole basis of the temperance movement will be shaken. The fault of the consequent reaction in the public mind must lie with those who believe that prejudgments rather than continuous study will enable them to find the right solution for any social difficulty. Every social problem belongs to a class embracing the hardest of all problems—it is vital not physical, it is biological, it is medical, it is statistical. It needs not less but far more investigation for its solution than any academic physical or biological problem. Yet every politician, every platform orator, who would hesitate to express even his opinion regarding a question in astronomical physics or cytology is ready with a decisive answer to each social problem that arises. The staff of the Galton Laboratory naturally lays no claim to any special infallibility in either conclusion or choice of method, but it does assert and will continue to assert that these social problems, with their intense complexity, cannot be solved by political and oratorical methods; they must be answered as all other scientific problems by investigation of an academic kind in university laboratories.

* *Archiv für Rassen- und Gesellschafts-Biologie*, Bd. I. S. 239.

† We might wish our temperance friends would take to heart the words of Edgar Allen Poe: "During the fits of alcoholic unconsciousness I drank—God knows how often or how much. As a matter of course, my friends referred the insanity to the drink, rather than the drink to the insanity."

Found such laboratories, provide them with the biological, medical and statistical equipment needful; create them in every university so that they may act as mutual checks! That is the manner in which physical and biological problems are solved, and nothing less will suffice in the case of these far harder problems. No solution is possible to men without academic leisure, without special training, who merely cite each other and weigh no evidence.

We have not discussed at length all the data provided by Sir Victor Horsley and his colleagues; we have merely sampled their material to indicate how little real knowledge flows from their methods of treatment. But if occasion arises we shall go further; our illustrations are not selected, they are a random sample of the "rebutting" evidence produced by the medical critics of our memoir. It is no discourtesy which prevents us from replying to the innumerable critics of our work in innumerable journals. We have thought it better to go to the core of the matter, and the nature of that core can be best illustrated in Sir Victor Horsley's method. It consists in mistaking occasional association for general causation; once that error is realised, the work of coping with the problem of alcoholism will have to be started *de novo*. It will be a national misfortune if temperance associations, societies for the study of inebriety, and popular writers on alcoholism pledge themselves to views which have no sound basis in observed facts, and expend their forces in invective rather than open-minded inquiry and sympathetic criticism.

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EUGENICS LABORATORY MEMOIRS. XIV

A PRELIMINARY STUDY OF EXTREME ALCOHOLISM IN ADULTS

BY

AMY BARRINGTON AND KARL PEARSON, F.R.S.

[illegible]

DAVID HERON, D.SC.

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The Laboratory is under the supervision of Professor KARL PEARSON, F.R.S., in consultation with Sir FRANCIS GALTON, F.R.S. Galton Research Fellow: DAVID HERON, M.A., D.Sc. Galton Research Scholar: ETHEL M. ELDERTON. Computer: AMY BARRINGTON.

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BY

AMY BARRINGTON AND KARL PEARSON, F.R.S.

WITH THE ASSISTANCE OF

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A PRELIMINARY STUDY OF EXTREME ALCOHOLISM IN ADULTS

(1) *Introductory.* A first paper on the subject of Alcoholism issued by the Galton Eugenics Laboratory deals with the influence of parental alcoholism on the health and mentality of the offspring as children. An inquiry concerning the various factors involved in the problem of extreme alcoholism in the adult is in some respects much harder, because available data are fewer and in many respects less definite. A great deal of useful information must lie buried in the records of the various inebriate reformatories, but as a rule the official reports only publish massed data, which, as in so many other cases, are of practically little service from the standpoint of modern statistical methods. Further, one cannot be certain, even if these records were available for examination, that the categories used for mental condition, physical state, education, occupation, conduct, &c., would be equivalents. Still, something of value would be certain to follow were there even approximation to uniformity in the categories used, and the official reports gave the actual record for each inmate individually. It is the want of *individual* records, which from the statistical aspect is the most serious defect of the official or annual reports of many institutions, in particular of asylums for the insane and reformatories for inebriates. By a suitable choice of symbols the account of 50 to 60 patients can be placed on a single page, and 4 to 5, or in the case of large institutions 10 to 12, pages of printed matter would provide all the requisite data and furnish a permanent record from which all manner of investigations might start.

That individual records can be quite easily printed is shown by the Annual Reports of the Langho, or Lancashire Reformatory. Such individual records are there given, which, although not quite complete, are nearly so. Owing to the great courtesy of Dr. F. A. Gill, the Director of the Lancashire Inebriates Reformatory, who has supplemented the data in his published reports, we have been able to obtain particulars as to the mental condition, physical state, and conduct of 207 female inebriates, and as to the age, number of convictions, religion, and education of 333 female inebriates. Most of the data as to the latter will be found fully recorded in the six Annual Reports of the Langho Reformatory from 1905 to 1910. Five of the latter group of 333 women had to be omitted from our tables because entries with regard to them failed under one or more categories. Such is the somewhat slender material discussed in the present paper, the object of which is in the first place to induce those in whose power it lies to tabulate and publish *individual*

records. It will, we think, be seen from this discussion that many interesting problems, here only suggested, can be definitely determined when this method of record has been more generally carried out.

(2) *The Factors of Alcoholism.* The chief problem concerning the alcoholist * is undoubtedly the discovery and due weighting of the factors which have led to his or her observed condition. If we find that the alcoholist is mentally or physically on a lower plane than the normal human being, are we to attribute one or both these states to the alcoholism, or is the alcoholism to a greater or less degree the result of mental or physical deficiency? To what extent is it a misfortune of environment which has brought about alcoholism, and has this in its turn produced mental or physical degeneracy? Or, are one or both of these only antecedents to the alcoholism, which has really resulted from them? Should the latter in whole or part be the case, we should anticipate that alcoholism would so far prove to be hereditary in that it would be associated with a type of constitution itself hereditary in character. The characteristics of such a constitution may then manifest themselves not only in alcoholism, but possibly in neuroses, insanity, mental defect, and criminality. Alcoholism might thus prove to be only one of several *aliases*, whose hereditary diathesis can only be expressed by some general term such as "want of mental balance". It will probably need a long and complicated inquiry to deal adequately with the many difficult points surrounding these problems. But it should be possible to throw some light on them by sifting the records of the inebriate reformatories. Do the physique and mentality of the alcoholic grow definitely worse as they age? Does alcoholism appear to be a result of defective education, of race, of religious belief or temperament? At least some information on these points ought to flow from the reformatory records.

(3) *The Relative Value of the Record of Convictions.* In order to justify legal detention in an inebriate reformatory at least four convictions must be proved against the individual.† It is not needful to state the whole number of previous convictions, and the police are not compelled to give a complete record of the police-court career of the individual. In many cases, of course, a woman keeps on reappearing at the same court or in the same district, and thus her previous history and number of convictions are well known to the police. A good number of the cases, however, belong to a floating, often a prostitute population, with many homes and many *aliases*, and relatively little attention is said to be paid to the true total of previous convictions, provided the legally requisite number, or probably some number in excess of it, has been demonstrated. On this account the number of convictions cannot be taken as a wholly satisfactory or absolute measure of the length or intensity of the alcoholism of the individual. We can conceive no more useful social work than the

* We are not aware whether this word has been previously used, but it is most inconvenient to have no separate noun and adjective and to use alcoholic for both.

† One or two exceptional cases, probably committed by consent, had less than the four convictions.

careful record of the lives of a hundred or more of these inebriates, with an exact enumeration of their police-court appearances. Failing this, are we to assume that the recorded number of convictions is perfectly idle as a measure of past alcoholic history, or on the other hand may it with due caution be used as the best measure at present available? While quite prepared to be told that in individual cases a woman with 12 convictions recorded against her, has been shown on fuller inquiry to have been convicted 40 times, we yet believe that such individual cases, while weakening, do not invalidate conclusions based on the assumption that the recorded number of convictions is a rough measure of the length and the intensity of alcoholic life. We believe in fact that—at any rate in the case of the Lancashire data—there exists a fairly high correlation between actual and recorded number of convictions. Our chief reason for this lies in the principle that if the number of convictions were given practically at random, provided it exceeded four, that number would be allotted in precisely the same manner as if we drew a number exceeding four out of a bag and handed one to each inebriate as her record. Of course it would come to the same result if we simply sorted out at random the numbers of convictions among the convicted, and this random sorting has actually been carried out with the results indicated in the table below:—

TABLE I. Mean Number of Convictions (207 cases).

	Actual.	Random Sortings.	
All Population	28·34	1st Trial. 28·34	2nd Trial.
Mentally, Normal	22·08	26·04	29·61
„ Defective . . .	33·35	30·17	26·75
Physically, Fit	26·64	27·82	28·03
„ Unfit	34·44	30·22	29·44
Conduct, Well-behaved . .	25·78	28·31	26·91
„ All others . . .	34·75	28·42	31·83

It will be seen that the actual number of convictions of those mentally defective or physically unfit, or not well behaved, is sensibly larger than those of the mentally normal or physically fit or well behaved. In the case of the random sortings this difference is not always preserved. The random variations between the means of each category of the three classes are also far less than those between the means of the actual characters. It seems accordingly reasonable to assert that while the correlations between number of convictions, and the moral, mental, and physical conditions might well be higher, if we had the exact instead of the recorded number of convictions, yet the recorded numbers are *some* measure of the length and intensity of the alcoholism. This may be further illustrated by the correlation of number of convictions with age of the inebriate. For the actual distribution $r = \cdot 29 \pm \cdot 04$.

Two random distributions were made of the convictions and ages, one gave $r = + \cdot 085 \pm \cdot 047$, the other gave $r = - \cdot 084 \pm \cdot 047$, neither significant having regard to their probable errors.* It may be argued that age would be far more highly correlated than the above value (·29) indicates with the actual number of convictions. Probably the true correlation is higher, but at the same time it must be remembered that alcoholism develops at different ages with different individuals; the alcoholism of the housewife may occur at a much later stage than that of the prostitute, who may reach the same total of convictions at a much earlier stage than the woman who has more means of privacy and more people to look after her in her bouts. On the whole the value found, while undoubtedly a minimum value, may not be so excessively in error, as a mere general impression of the rough character of the recorded number of convictions might lead one to suppose. We think accordingly that the recorded number of convictions is of some value, and that it is worth while to see what suggestions flow from taking it as some rough measure of the intensity of the alcoholism.

(4) *Categories used for Characteristics of Inebriates.* The classifications at Langho having been made by one medical superintendent are therefore subject solely to one personal equation, and this is an advantage, to some extent compensating for the smallness of the totals available from one reformatory.

Dr. Gill has the following categories of mental condition: *Average*, *Slightly Defective*, *Defective*, *Very Defective*, and *Insane*. The numbers (207) are so few that we have for purposes of reduction classed these as *Normal* (= *Average*) and *Defective* (= all the rest).

In Dr. Branthwaite's *Report* for 1908 we have the following definitions and details for 3,032 inebriates. Unfortunately for our present purpose males and females are combined:—

(i) Average mental capacity on admission or after six months' detention, 1,105 = 36·45 %. (ii) Defective—Persons who are eccentric, silly, dull, senile, or subject to periodical paroxysms of ungovernable temper, 1,487 = 49·04 %. (iii) Very defective—Persons who after admission to reformatories were found to be more or less congenitally imbecile, degenerate, or epileptic, 377 = 12·43 %. (iv) Insane—Persons who since admission to reformatories have been certified and sent to asylums, 63 = 2·08 %.† Hence the total percentage in whom want of mental balance was found amounted to 64 %. This is strikingly close to the Langho total (see our p. 25) of 63 %, although in the latter case we have females only. This correspondence necessarily gives us greater faith in the relatively smaller numbers we have been able to use. We are credibly informed that in one large female prison in this country 80 % of the prisoners are mentally defective, and among male convicts Goring reports 45 % as mentally defective. Now we have had the great advantage

* The fact that they should have come so nearly equal but of opposite signs is, of course, only casual.

† This percentage cannot be *very* largely in excess of insanity in the general population.

of consulting Dr. James Kerr with regard to the relation of this scheme to the classification of mentally defective children. He considers that the value he gave to the Committee making inquiries in 1906 of 2 % has been more or less justified. After that Committee the estimates gave 1 %, but the estimated values have been gradually rising since, and will apparently reach 2 %.* The definition of mental defect is, however, one made purely for scholastic purposes, and means children requiring education in other ways than the ordinary elementary school. The shades of defect are so gradual that the estimate of numbers must always depend on personal equation until some comparatively accurate mode of estimation has been established. At present all we can say is that the estimate of mental defect in school children runs from something under 1 % to something under 2 %, according to locality and observer. If the classification used for inebriates be compared with that for school children, there are one or two points which present difficulty. In Class (iii) the term "degenerate" is very hard to interpret, and probably it is impossible to distinguish such cases from many in Class (ii).† Again, there is a real need for a class between (i) and (ii), at any rate for scholastic purposes, namely (i) ^{bis}, which Dr. Kerr would define as follows: "Backward, generally incapable of average attainment in more abstract matters, and much behind in school work." The differentiation of (i) ^{bis} and (ii) is where most personal equation would enter. Many of (i) ^{bis} can only be distinguished from (ii) after prolonged observation, and (ii) undoubtedly contains a proportion of neglected children. But on broad lines (ii), (iii), and (iv) correspond to the mentally defect of the scholastic classification, and amount to something under 2 %. Class (i) ^{bis} probably contains another 5 % to 10 %, but has hardly yet been properly estimated. The above allocation indicates the point where we had already drawn our division before consulting Dr. Kerr, and it is of great value to us to have his opinion that the mentally defective of the schools embrace substantially Classes (ii), (iii), and (iv) of Dr. Branthwaite's classification.

In actually dealing with the school material, we have to remember that the mentally defective children, except in very marked and obvious cases, are not drafted at once into the special schools—probably not till the age of 9 or 10, when they have left the infant schools. Working on statistics provided by Dr. Kerr, which include mentally defective children in the special schools and children certified as such in the ordinary schools, we find the following percentages for London:

Boys: 1·59 Girls: 1·09

Through the courtesy of Dr. E. W. Hope, Medical Officer of Health for Liverpool, we find from similar data:

Boys: ·827 Girls: ·618

* Pearson, *Biometrika*, vol. v, p. 111, from data from his school investigations gives 1·88 % of very dull and imbecile children.

† The subclass here with paroxysms of ungovernable temper probably have some features of an epileptic nature.

This Liverpool return is of importance to us as being nearer to the population from which Langho is chiefly recruited. In both London and Liverpool cases there would be a considerable reduction of these percentages, if the "Infants" were included in the totals, but we do not think this justifiable, and our results without this inclusion will indicate a *minimum*, not a maximum limit to the correlations between mental defect and alcoholism, which we are seeking. Clearly the school returns would indicate that 1 % of mental defect in females * is to be expected in the community at large, as against the 64 % found among inebriates.

For physical condition Dr. Gill divides simply into *Fit for hard work* and *Unfit for hard work*; for brevity we speak of these as *Fit* and *Unfit*. In the case of conduct in the reformatory he divides into *Well-behaved*, *Manageable*, *Troublesome*, and *Very Troublesome*. The last two categories contain only 4 % and 5 % of the inmates; † we have accordingly, for statistical purposes, had to throw them in with the *Manageable*. This is unfortunate, but such small percentages cannot be dealt with effectively until far larger numbers are available; no wise statistician will trust to means based on 8 or 10 individuals. The *Manageable* certainly mean those who need management, or they would be under the well-behaved. They are probably troublesome or difficult by nature, but manageable owing to their experience of the ill effects of bad conduct on their own comfort. ‡ Thus of the manageable 60 % are defective mentally, while of the well-behaved only 27 %; again 90 % of the former and only 75 % of the latter are physically fit. In other words the "manageable" class are physically fitter, but mentally more defective than the well-behaved.

Two classifications of education may be made which are of extreme service. The one records the nature or class of education which has been provided, the other marks the profit which the individual has received from it. We shall speak of these as *formal* education, and *effective* education. It should be noted that for the class we are dealing with the category of both types of education is practically settled when the alcoholist was a child, and before the onset of alcoholism. Any relationship between these education categories and other characters of the alcoholist is a relation which to a large extent must antedate the alcoholism.

The formal education categories are *Good*, *Fair*, *Elementary*, *Poor*, *Imperfect*, *Very Little*, *Defective*, *Bad*, and *Nil*. We have had to content ourselves, considering the total numbers at our disposal, with placing the first three categories together as *Better Education*, and the remainder as *Worse Education*.§ The effective education

* The greater percentage of mental defect in boys has been already recognized, but so far no explanation is forthcoming.

† Dr. Branthwaite (*Report*, 1908) gives details as to conduct of 3,032 *male* and female inebriates. The four classes give respectively: 1,746, 763, 285, 238, or 57·59 %, 25·16 %, 9·4 %, 7·85 %.

‡ Beyond the risk that extreme troublesomeness may involve the culprits being treated as insane and sent to an asylum, certain cases are transferred every year to the State inebriate reformatories, where the discipline is probably sterner.

§ Even this division is not satisfactory. At Langho it gives 270 individuals with *better* and only

categories are: (1) Can neither read nor write, (2) Read and write imperfectly, (3) Read and write well, (4) Superior education. It will be seen that these categories turn largely on the profit obtained by the formal education. The classification by means of effective education is far more satisfactory from the statistical standpoint than that by means of formal education. If we put (1) and (2) together as worse education, and (3) and (4) as better education, we find 73·4 % with worse and 26·6 % with better education, as against 82·3 % and 17·7 % on the formal education categories.* In order to test the nature of the association between the two stages of education we have correlated them together: see Table X. The co-efficient of mean square contingency = ·482; we consider this is a better result than that given by a fourfold table (Table X bis), both classifications being into *Better* and *Worse*, i.e. $r = \cdot 356 \pm \cdot 041$. Either show that the relation between the two classifications is not very high; that it is as high as it is is probably due to the fact that the formal education classification used is really of a rather mixed kind, and some weight has undoubtedly been given in it to effective education. We may throw still further light on the relationship by examining the correlation of mental capacity and education classified in the two ways. We find: see Tables G, G bis and G′, G′ bis:

Correlation of Mental Capacity and Formal Education: ·341 ± ·041,
" " " and Effective Education: ·644 ± ·027.

The latter is almost double the former. It is difficult to understand how the degree of mental defectiveness should be associated with either educational classifications, if that defectiveness were the product of alcoholism and not an antecedent to it, for, as we have remarked, education in the bulk of these women is almost entirely determined by the conditions of childhood. The partial correlations tend to confirm the view that the mental defect largely antedates the alcoholism. We have:

Mental Capacity and Formal Education for a constant Effective Education	·046 ± ·047
Mental Capacity and Effective Education for a constant Formal Education	·582 ± ·031

The first is non-significant, the mental deficiency has no relation to the type of education received; the second is hardly less than the total correlation, and indicates that the profit from education is closely associated, for a constant form of education, with the mental capacity as judged in adult life. This is precisely

58 with *worse* education. The bulk of all cases fell into the *elementary* class. Had the *Better Education* been limited to *Good* and *Fair* it would have contained only 25 individuals. We need to split up the big *Elementary* class; it possibly might be done by stating the standard reached.

* Dr. Branthwaite (*Report*, 1908) gives for the distribution of 3,032 *male* and female inebriates in the four classes: (1) 421 = 13·99 %, (2) 1,465 = 48·32 %, (3) 1,006 = 33·18 %, (4) 140 = 4·62 %. These are not so close to the Langho results—i.e. (1) 20·29 %, (2) 53·14 %, (3) 22·22 %, (4) 4·35 %—as in some other cases. This is probably due to the large Irish element at Langho.

what we should anticipate, if the adult mentality were closely related to the mentality of childhood. It is less easy to account for this association of effective education of childhood and the mentality of adult life, if the latter were in any marked degree a product of alcoholism produced by environmental conditions. We shall return to this point later. We have referred somewhat out of place to it here as justifying us in retaining the two educational classifications. The formal classification is admittedly unsatisfactory, but if extended it might distinctly be of service as a measure of environment in childhood, and enable us more definitely to analyse the current conception that alcoholism is due to defective education. Those who use the phrase rarely distinguish between formal and effective education, and still more rarely between causation and association. We have three characteristics which undoubtedly are associated in a high degree: defective education, alcoholism, and defective mentality. It has been too often asserted without any scientific investigation (especially by the earlier advocates of State compulsory education) that if education were universal and of a high grade, there would be less drunkenness, and as a result less insanity and imbecility in the population. This may or may not be correct; it is quite certain that it receives no proof whatever from the statistical data usually provided in favour of it.

In the matter of religion we have only found it possible to classify the Langho inebriates into Roman Catholics and Protestants; the few data as to the division of the latter are not enough to be of service. The question we had in view in dealing with religion in this matter was really to approach indirectly the problem of race. It seems probable that the bulk of the Roman Catholics at Langho are Irish. The appearance of 166 Catholics and 162 Protestants in a Lancashire Reformatory is itself somewhat noteworthy.* If we examine the localities from which the convicted were sent, we find that in the case of Liverpool 50 % of the women were Roman Catholic, 50 % were Protestant; in the case of Manchester 33 % were Roman Catholic, 67 % Protestant. This emphasizes the view that we are dealing under Roman Catholics largely with Irish immigrants. As a race the Irish prefer whisky to beer, and new or bad whisky, which is all that is obtainable by the very poor, may be more likely than other forms of alcohol to bring them directly into conflict with the police. It is, perhaps, also unnecessary to add that the Irish immigrants into the Lancashire towns are far from being the best section of the Irish race.

Another important matter which arises in the course of investigations into the social status of these female inebriates is the question of their occupation. Does the absence of definite occupation drive women to alcoholism? This question is one which cannot be answered at all on the material which finds its way into Langho. Absence of occupation must mean independent means, and only one woman at Langho is recorded as having independent means. Every woman, whether single, married,

* There is no special entry for race in the records. Of those at present in the Reformatory, 41, Dr. Gill tells us, are Irish, and this is probably 50 % of the inmates; the bulk of these will be Catholics.

or widowed, against whom a blank or "nil" was recorded in the occupation column was actually a prostitute, and we found that correlations involving prostitute and non-prostitute were identical with those of occupied and non-occupied, with the exception of the single case just referred to. To say that a woman has no recorded occupation is accordingly merely another manner of stating that the inebriate is by profession a prostitute. We can from our data judge something of the relations of prostitution to alcoholism, but not of the want of occupation to alcoholism. Such is the nature of our material and of its classification; we now turn to the conclusions which may be drawn from it.

(5) *To what extent are Alcoholists differentiated by Mental Capacity from the General Population?* We have already seen that 64 % of convicted male and female inebriates in general and 63 % of female inebriates at Langho are mentally defective in a higher or lower degree. Now we are all fully certain that over 64 % of defectives do not exist in the general population, but it is not so easy to determine what is the proportion of mental defect. We accordingly, with a view of throwing some light on this matter, applied to Dr. James Kerr for data as to the amount of mental defectiveness in the London Schools, and to Dr. E. W. Hope for the similar data as to Liverpool, as closer to the district from which Langho draws its material. They most kindly provided us with the data from which the estimates given on p. 9 were drawn. We shall take these estimates as alternative limits to the extent of mental defect in the population at large. It is perfectly true that these estimates are for the *child* population, but they will give us at least a maximum limit to mental defect in the adult population. This follows because (i) there is accumulating evidence to show that mental defect is hereditary, (ii) the death-rate among these children is undoubtedly higher than among normal children, (iii) the slighter cases of mental defect among children, owing to the influence of training, may not be reckoned as cases of mental defect in adult life. We do not think, therefore, we shall err widely by assuming the percentages in childhood to apply to adult life, even if a certain amount of mental defect is first apparent after adolescence is reached.

Now let us make a table of the following kind:

Mentality.	Rest of Population.	Convicted Inebriates.	Totals.
Normal	x	92	$92+x$
Defective . . .	y	115	$115+y$
Totals . .	$x+y$	207	$207+x+y$

In this table x and y are at present unknown; we have given the inebriates the proportions they bear, 92 to 115, in the smaller sample of the Langho women. There is a fundamental point to be observed about this table; it does not divide the population into the alcoholic and non-alcoholic. The division is made a long distance into the alcoholic section—namely, the tail of extreme chronic alcoholists, women

who have been convicted on an average at least * 28 times, is cut off. Furthermore, they are not necessarily the worst cases, but those who have the least control over their action, and by offences against public order are brought into conflict with the police. There can be little doubt that these women are to a considerable extent selected by reason of their mental defect. As in the case of criminals, the abler and less mentally defective probably do not so frequently fall into the hands of the police. Putting this fact on one side for the present purpose and supposing our convicted inebriates to be, as they closely must be, the worst cases of alcoholism, let us endeavour to measure the correlation of alcoholism and mental defect on the assumption that mental capacity and the tendency to alcohol are continuously varying quantities. It will be clear that $(115+y) \div (207+x+y)$ will give the ratio of mentally defective women to all women of the given ages. Assuming that we may take the proportions indicated by the school returns this will be ·010,900,5 for the London and ·006,181,65 for the Liverpool estimates. In the next place $207/(207+x+y)$ is the ratio of convicted alcoholists (A) to the general population (P). In a society like our own this ratio (R) will, like most statistical ratios, remain fairly stable for some years, and accordingly the ratio of the variation in A to the variation in P, i.e. $\delta A/\delta P$, will also be closely equal to R. Now we can find this ratio. It is the ratio of the increase in the numbers of convicted alcoholists, less the death-rate among the total convicted population in or out of reformatories, to the increase in the population out of which the convicted inebriate women are drawn. According to the Langho returns, the youngest inebriate woman is 16 and the oldest 69. It would seem, therefore, that the convicted inebriates are not drawn from the oldest section of the population. We have accordingly taken δP, the annual change in P to be the number of women aged 15 less the number of women aged 69 less the number of deaths of women between ages 16 and 69. The population of females was taken from the 1901 Census † and brought up to the basis of the estimated population for 1908. The value of the deaths was taken from the Registrar-General's *Annual Report* for 1908. The number of women aged 15 in 1907 and 69 in 1907 would respectively have entered and left the population P in 1908. Our estimates which must necessarily be and need only be approximate were:

Number of women aged 69 in 1907 = 65,260.
Number of women aged 15 in 1907 = 351,594.
Number of deaths 16 to 69 = 107,353.

Hence $\delta P = 351{,}594 - 107{,}353 - 65{,}260 = 178{,}981$.

Our estimated value of number of women between 16 and 69 for the year 1908 was 11,648,969.

The next point is to find δA. This consists of two parts δA_1 = number of new convictions and δA_2 = number of deaths among the already convicted alcoholists in

* "At least" because the recorded number of convictions is asserted to fall below the actual number.

† England and Wales.

and out of prison. We have taken for δA_1 the average convictions as given by Dr. Branthwaite's Report for 1908, for 1904, 1905, 1906, and 1907 * reduced to three-quarters of their value. The reduction to three-quarters is based upon the Langho returns which indicate that 25 % of the convictions are reconvictions. This is very probably below the true value, but it is difficult to get accurate data with regard to this point. Thus we have:

$$\delta A_1 = \tfrac{3}{4} \times \{\tfrac{1}{4}(380+352+294+428)+3\}\,\dagger\; = 274{\cdot}875.$$

Let $\lambda_1 A$ be the number of alcoholists who die in and out of prison, and let $\lambda_2 P$ be the number of women who die between 16 and 69. Then $A = RP$ and accordingly $\delta A_2 = \frac{\lambda_1}{\lambda_2} \times R \times \lambda_2 P = K \times R \times 107{,}353$, where K is a number representing the ratio of the death-rates. Now from the 1901 Census the average age of women from 16 to 69 is 36·05 and the average age of 328 female alcoholists at Langho between 16 and 69 is 36·39. There cannot therefore be much difference between the age distribution as judged by this standard; it is probable, however, that there are fewer very young and very old alcoholists, and thus the mean ages of alcoholists and general population are brought very closely together. To allow for this we have supposed (i) that the death-rate of these chronic alcoholists is only equal to that of the general population of women of the same mean age, (ii) that it is double that value. Neither of these hypotheses may be correct, but at least they will give a measure of how the correlation of alcoholism and mental defect is modified when we increase the relative death-rate of the alcoholists. We shall accordingly put $K = 1$ and $K = 2$ as standard cases. We have for the stability of the population

$$\frac{\delta A_1 - KR\,(107{,}353)}{\delta P} = R$$

$$\begin{aligned} \therefore\ R &= \delta A_1/(\delta P + K \times 107{,}353) \\ &= 274{\cdot}875/(178{,}981 + K \times 107{,}353) \\ &= {\cdot}000{,}959{,}980, \qquad \text{if } K = 1, \\ &= {\cdot}000{,}698{,}207, \qquad \text{if } K = 2. \end{aligned}$$

Now $P = 11{,}648{,}969$ in 1908,

$$\begin{aligned} \text{Hence } A = RP &= 11{,}183, \qquad \text{if } K = 1, \\ &= 8{,}133, \qquad \text{if } K = 2. \end{aligned}$$

In other words, had the present system been in existence long enough we should have had somewhere between 8,000 and 11,000 convicted female alcoholists in or out of reformatories. Allowing for the death-rate roughly, it would have taken at the present rate of convictions 40 to 50 years to have passed this number through the reformatories; of course a much longer period than the system has been at work. About $\frac{1}{41}$ to $\frac{1}{30}$, according to which value of the death-rate we use, is added by conviction to the total convicted alcoholist population each year.

* 1908 was not used, because, for reasons stated in the *Report*, it was 50 % below usual value.

† Here the 3 is introduced to account for transfers to State-prisons.

We are now in a position to write down our equations and form our tables; we have:

$$\frac{207}{207+x+y} = \cdot 000{,}959{,}980, \quad \text{or} = \cdot 000{,}698{,}207,$$
$$(K = 1) \qquad\qquad (K = 2)$$

$$\frac{115+y}{207+x+y} = \cdot 010{,}900{,}5, \quad \text{or} \quad = \cdot 006{,}181{,}65.$$
$$\text{(London percentage)} \quad \text{(Liverpool percentage).}$$

These alternative equations may be coupled in four ways giving the following values of x and y:

Death Rates.	$K = 1.$		$K = 2.$	
Mental Defectives.	$x =$	$y =$	$x =$	$y =$
London Percentage . . .	213,187	2,235	293,150	3,117
Liverpool Percentage . .	214,204	1,218	294,549	1,718

These lead us to the following fourfold tables:

(i) London Percentage of Mental Defectives. Death-rate of Convicted Alcoholists equal to that of the General Population.

	Not C. A.	C. A.	Totals.
Normal	213,187	92	213,279
Mentally Defective . .	2,235	115	2,350
Totals	215,422	207	215,629

(ii) London Percentage of Mental Defectives. Death-rate of Convicted Alcoholists twice that of the General Population.

	Not C. A.	C. A.	Totals.
Normal	293,150	92	293,242
Mentally Defective . .	3,117	115	3,232
Totals	296,267	207	296,474

(iii) Liverpool Percentage of Mental Defectives. Death-rate of Convicted Alcoholists equal to that of the General Population.

	Not C. A.	C. A.	Totals.
Normal	214,204	92	214,296
Mentally Defective . .	1,218	115	1,333
Totals	215,422	207	215,629

(iv) LIVERPOOL PERCENTAGE OF MENTALLY DEFECTIVES. DEATH-RATE OF CONVICTED ALCOHOLISTS TWICE THAT OF THE GENERAL POPULATION.

	Not C. A.	C. A.	Totals.
Normal	294,549	92	294,641
Mentally Defective . .	1,718	115	1,833
Totals	296,267	207	296,474

These four tables lead to the following four equations:

$$\text{(i)}\ 5{\cdot}61540 = r + 3{\cdot}55847r^2 + 6{\cdot}12720r^3 + 4{\cdot}44449r^4 - {\cdot}27876r^5 - 1{\cdot}11864r^6 + {\cdot}75758r^7 - {\cdot}30710r^8;$$

$$\text{(ii)}\ 5{\cdot}47103 = r + 3{\cdot}66488r^2 + 6{\cdot}54215r^3 + 4{\cdot}98062r^4 - {\cdot}33917r^5 - 1{\cdot}73411r^6 + {\cdot}52048r^7 - {\cdot}33719r^8;$$

$$\text{(iii)}\ 9{\cdot}31956 = r + 3{\cdot}88064r^2 + 7{\cdot}56063r^3 + 6{\cdot}98079r^4 + 1{\cdot}45753r^5 - 1{\cdot}03394r^6 + 1{\cdot}19942r^7 + {\cdot}72012r^8;$$

$$\text{(iv)}\ 9{\cdot}08081 = r + 3{\cdot}99677r^2 + 8{\cdot}07134r^3 + 7{\cdot}82402r^4 + 1{\cdot}76820r^5 - 1{\cdot}60585r^6 + {\cdot}82421r^7 + {\cdot}78930r^8;$$

and there result the following four correlation coefficients:

	Death-rate of Alcoholists. Equal to Normal.	Twice Normal.
London percentage:	$r = {\cdot}705$,	$r = {\cdot}688$,
Liverpool percentage:	$r = {\cdot}773$,	$r = {\cdot}747$.

Thus notwithstanding considerable changes in the death-rate and the percentage of defectives assumed for the general population, we find a very high relationship, ·70 to ·80, between alcoholism and mental defect. It is true that as in the case of criminality this association has been often asserted, but the object of the inquiry in this section has been to obtain by approximate but reasonable assumptions a *numerical* measure of its intensity. No fact is fully appreciated until we have such a measure of its significance.

The chief objections that may be raised against our methods are:

(i) We have taken the mental defectiveness of childhood as a measure of the prevalence of mental defect in adult life. Now certainly a higher number of these mentally defective children die than of normal children. The effect of a lesser amount of defectiveness in adult life would, however, *increase* the correlation. The same change would occur, if we lessen the adult defectiveness by supposing some mentally defective children to become normal adults. Even if mental defect were itself the product of alcoholism, we can hardly accept the view that this or other source of mental defect in adults would cause the number of adult mentally defectives to exceed largely the proportion in the child population. The London estimate of mental defect is 1·76 times the Liverpool estimate, but this wide difference has only made

a change of about 8 or 9 % in the correlation, a change almost within the probable error of the result.

(ii) It may be argued that the female convicted inebriates are not selected by the fact of their extreme alcoholism, but by the effect of their stupidity, which throws them into the hands of the police. In the case of women, a large percentage of whom are prostitutes with no protection when in a state of alcoholism, it may, however, be doubted whether any degree of intelligence would preserve them from conflict with the police when drunk. The argument should be borne in mind, as it may to some extent account for the very high correlation. At the same time it should be noted that by using the 207 sample we have reduced the extent of the mentally defective among the inebriates to 55·5 %, a figure considerably below the 63 % of the larger Langho numbers or the 64 % of Dr. Branthwaite's figures. We could thus allow a good deal to the selective action of stupidity without sensibly altering the result.

We are inclined, however, to hold that the convicted female inebriates represent an average mental sample of extreme chronic alcoholists, and to assert that there exists a correlation of something like ·70 to ·80 between mental defect and alcoholism in the population of this country. Of these two characteristics, which is antecedent and which is consequent? That is the real problem of alcoholism in its extreme forms.

(6) *Preliminary Remarks on Prostitution and Alcoholism.* Working on the same lines as the previous section we can obtain an estimate of the number of convicted* prostitute inebriates in the community (England and Wales). According to the Langho data among the inebriate prostitutes the normal and the mentally defective are in the ratio of 36 to 47. This gives a percentage of 56·6 %, slightly greater than that of the like classes in all convicted inebriates as given in the 207 sample, but less than the 64 % as provided by the larger returns. We shall discuss certain features of the distribution of intelligence in prostitutes later on. Working from this 56·6 % basis, we may, we hold, reasonably assume that the ratio of alcoholic prostitutes (π_ρ) to all alcoholists is a fairly stable statistical constant. In other words we have:

$$\delta\pi_\rho/\delta A = \pi_\rho/A = 83/207$$

$$\begin{aligned}\text{but } \delta A &= 274{\cdot}875 - {\cdot}000{,}959{,}980 \times 107{,}353 \ (K = 1)\\ &= 274{\cdot}875 - {\cdot}000{,}698{,}207 \times 2 \times 107{,}353 \ (K = 2)\\ &= 171{\cdot}818 \ (K = 1) \text{ or } 124{\cdot}966 \ (K = 2).\end{aligned}$$

This gives: $\delta\pi_\rho = 68{\cdot}893$ ($K = 1$) or $50{\cdot}107$ ($K = 2$) leading to: $N = 215{,}630$† and 296,474 practically agreeing with the values on p. 16 above. We have $\pi_\rho = 4{,}484$ and 3,261, as the number of convicted alcoholic prostitutes that would exist in the community had the system been long established. We have accordingly

* This word is of course used in a special sense; the estimate obtained is of those who would have been convicted had the system been for 40 or 50 years in working order.

† We have used 215,629 as in the previous Tables.

the tables given below on the fourfold hypotheses, where we have assumed the death-rate of the prostitute class to be either once or twice the general death-rate.

The following four equations were obtained for the correlation coefficients:

$$\text{(i)}\quad 5{\cdot}33964 = r+3{\cdot}85792r^2+7{\cdot}32635r^3+6{\cdot}04618r^4-{\cdot}46426r^5 -3{\cdot}17811r^6-{\cdot}24657r^7-{\cdot}47007r^8.$$

$$\text{(ii)}\quad 5{\cdot}21721 = r+3{\cdot}95719r^2+7{\cdot}74521r^3+6{\cdot}64113r^4-{\cdot}54046r^5 -4{\cdot}11265r^6-{\cdot}90811r^7-{\cdot}44316r^8.$$

$$\text{(iii)}\quad 8{\cdot}86042 = r+4{\cdot}20719r^2+9{\cdot}03833r^3+9{\cdot}49651r^4+2{\cdot}42743r^5 -2{\cdot}93745r^6-{\cdot}30938r^7+1{\cdot}10180r^8.$$

$$\text{(iv)}\quad 8{\cdot}65796 = r+4{\cdot}31555r^2+9{\cdot}55561r^3+10{\cdot}43239r^4+2{\cdot}81755r^5 -3{\cdot}80154r^6-1{\cdot}43804r^7-1{\cdot}05941r^8.$$

These give (i): $r = {\cdot}665$, (ii): $r = {\cdot}649$, (iii): $r = {\cdot}715$, (iv): $r = {\cdot}706$.

(i) London Percentage of Mentally Defectives. Death-rate of Convicted Alcoholic Prostitutes equal to that of the General Population.

	Not a C. A. P.	C. A. P.	Totals.
Normal	213,243	36	213,279
Mentally Defective . .	2,303	47	2,350
Totals	215,546	83	215,629

(ii) London Percentage of Mentally Defectives. Death-rate of Convicted Alcoholic Prostitutes twice that of the General Population.

	Not a C. A. P.	C. A. P.	Totals.
Normal	293,206	36	293,242
Mentally Defective . .	3,185	47	3,232
Totals	296,391	83	296,474

(iii) Liverpool Percentage of Mentally Defectives. Death-rate of Convicted Alcoholic Prostitutes equal to that of the General Population.

	Not a C. A. P.	C. A. P.	Totals.
Normal	214,260	36	214,296
Mentally Defective . .	1,286	47	1,333
Totals	215,546	83	215,629

(iv) Liverpool Percentage of Mentally Defectives. Death-rate of Convicted Alcoholic Prostitutes twice that of the General Population.

	Not a C. A. P.	C. A. P.	Totals.
Normal	294,605	36	294,641
Mentally Defective . .	1,786	47	1,833
Totals	296,391	83	296,474

We see that there is again a very high correlation between mental defect and alcoholic prostitution. There is small doubt that it is in these cases that prostitution takes its most baleful form; it is probable that in the lowest grades of prostitution all with scarcely an exception are alcoholic. Our table may therefore approximately represent the general relation between prostitution and mental defect without regard to alcoholism; we have merely drawn a line across the population at extreme forms of prostitution, and we find that prostitution is intimately associated with mental defect. Our data—through no fault of our own—are very slender, and it would be idle on their basis to assert that mental defect is more closely associated with alcoholism than with prostitution.* But we have evidence enough to show that the three factors, prostitution, alcoholism, and mental defect, are all closely related. Which again of these, we ask, is antecedent, which are the consequents? Do prostitution and mental defect result from a tendency to drink? Or does the life of a prostitute lead to alcoholism and mental defect? Or, lastly, is the mental defect the antecedent to both prostitution and alcoholism? Of course it is quite possible that each of the three factors may in different cases be either primary or secondary; of one thing, however, we are certain; there are very considerable numbers of mentally defective girls in this country who, as they pass towards womanhood and out of any control, undoubtedly become both prostitutes and alcoholic. Until the life-history of such girls is more fully recorded and their numbers better known, it is idle to assert that because mental defect and prostitution are found closely associated with alcoholism they are the results of it. We might with equal want of logic assert that mental defect flows from criminality because of its very close association with it. The mentally defective man—in a large number of cases alcoholic—who is convicted of crimes of violence, rape, or arson, has the same origin, and is governed by largely the same impulses as the mentally defective woman who takes to prostitution and extreme alcoholism. We gain little for social reform when we assert that alcohol is the chief source of prostitution, crime, imbecility, and insanity, as long as we have not demonstrated that congenital mental defect is itself insufficient to produce the great bulk of the alcoholism, prostitution, and crime. It appears to us that ampler statistics carefully collected by organizations already existing might within a reasonable time give a quite definite answer to the problem of whether in the main alcoholism or mental defect, or again prostitution or mental defect, is the antecedent. We know from the school medical examinations that much mental defect antedates crime, alcoholism, and prostitution. Why, when we meet mental defect once more in the adult criminal and prostitute, are we to assume it, without any careful inquiry, as a new product, the result of alcoholism? Association is not necessarily causation.

(7) *Relation of Alcoholism to Education, Religion (? Race), and Age.* In this section we are able to deal with 328 cases for formal education, but only 207 cases for effec-

* In the 207 sample the prostitutes showed 56·6 % of mental defect, slightly more than the other alcoholists. But the convicted alcoholists in general show 64 %.

tive education.* We give the results for both under the headings respectively of F. E. and E. E. We first consider tables of means.

TABLE IV. MEANS FOR RELIGION (? RACE). (SEE TABLES E AND C.)

Mean.	Total.	Roman Catholic.	Protestant.
For Age	36·39	35·77	37·02
For Number of Convictions . .	28·21	33·27	23·03

TABLE V. MEANS FOR EDUCATION. (SEE TABLES D, B, D′, B′.)

Mean.	Total.		Better Educated.		Worse Educated.	
	F. E.	E. E.	F. E.	E. E.	F. E.	E. E.
For Age	36·39	35·82	35.44	34·74	40·78	36·21
For Number of Convictions . .	28·21	28·34	25·52	16·18	40·76	32·74

TABLE VI. FREQUENCY FOR EDUCATION. (SEE TABLES F AND F′.)

Religion (? Race).	Better.		Worse.		Totals.		Percentages.			
							Better.		Worse.	
	F. E.	E. E.	F. E.	E. E.	F. E.	E. E.	F. E.	E. E.	F. E.	E. E.
Roman Catholic .	129	73	37	40	166	113	78 %	65 %	22 %	35 %
Protestant . . .	141	79	21	15	162	94	87 %	84 %	13 %	16 %
Totals . . .	270	152	58	55	328	207	—	—	—	—

These results are of great interest. They indicate (Table VI) (i) that the Roman Catholics (? the Irish) have formally a worse education than the Protestants (? the English), and that their general profit by what education they have is markedly less —the percentage in the Roman Catholics who cannot read and write properly is more than double what we find in the Protestants; (ii) that the Roman Catholics (? the Irish) have an intensity of alcoholism—as measured by number of convictions—(Table IV), which is nearly 50 % greater than that of the Protestants, and this result is reached although the Protestant inebriates are slightly older; (iii) there is a difference of more than five years between those better and those worse educated *formally*, which reduces, however, to only 18 months when we consider the *effectiveness* of education. This indicates that probably some of the older inebriates were children before education became compulsory.

* We actually worked out our results first on a subsample of 152 inebriates in order to test their legitimacy. But no differences, other than those compatible with the larger probable errors of the smaller sample, were sensible in our results. There was always an excess of the same means in the differentiated classes and the correlations were in the same sense. We have not therefore thought it needful to publish the results of this subsample alongside the figures for the fuller record.

In the present matter another table is of some interest, namely, that showing the relationship of prostitution to religion.

TABLE VII. PROSTITUTION AND RELIGION.

	Roman Catholic.	Protestant.	Totals.	Percentages.	
				Roman Catholic.	Protestant.
Non-Prostitute . . .	124	107	231	75 %	66 %
Prostitute	42	55	97	25 %	34 %
Totals	166	162	328	—	—

It is clear, therefore, that the Roman Catholic inebriates are less frequently prostitutes than the Protestants.* This might at first sight appear as if the Roman Catholic faith had a restraining influence, but we fear it is not possible thus to interpret it. The population from which the material is drawn has a large Protestant majority; there is therefore a larger percentage of alcoholists among the Catholics (? Irish); but the Protestant majority, whatever it may be, is certainly greater than the ratio of 55 to 42. In other words, out of the general population more than the proportionate number of prostitute alcoholists are drawn from the Catholics (? Irish). Why, therefore, do they show a less percentage of prostitution among their alcoholists? We fear the only answer that can be made is that alcoholism exists among the married and occupied Catholic (? Irish) women to a greater extent than among the Protestants. This is illustrated in the following table:—

TABLE VIII. CIVIL STATUS, PROSTITUTION AND RELIGION.

Status.	Roman Catholic.		Protestant.		Totals.	Number per 100,000.			
						Roman Catholic.		Protestant.	
	Non-Prost.	Prost.	Non-Prost.	Prost.		Non-Prost.	Prost.	Non-Prost.	Prost.
Married . . .	60	10	63	15	148	38	6	20	5
Widowed . .	14	4	11	6	35	9	3	3·5	2
Single . . .	50	28	33	34	145	32	18	10·5	11
Totals . .	124	42	107	55	328	79	27	34	18

We have taken the population of Liverpool as giving most Catholics. Here, judging from the report of the Education Committee, August, 1910, the children in Catholic schools were less than $\frac{1}{3}$ of the whole population of children. Hence, as some Catholics may go to Council schools,† we have taken the ratio roughly as 1 to 2. On

* The actual correlation obtained by a fourfold table is: $-{\cdot}135$ between Catholicism and prostitution among convicted alcoholists.

† Dr. E. W. Hope informs me that the Roman Catholic children in the Council schools do not certainly exceed 0·4 per cent.

the Liverpool percentage of mentally defective and with the higher death-rate of alcoholics, 207 convicted alcoholists are drawn from a population of 296,474, and hence 328 from one of 469,775, of whom we should have 156,592 Roman Catholics and 313,183 Protestants. The second half of our table gives the returns for 100,000 Roman Catholic (? Irish) women and 100,000 Protestants of the number of convicted alcoholists of each status who would be prostitute and non-prostitute. We see at once that, while the prostitute element is greater for each status, the Roman Catholic total being 50 % higher than the Protestant, the non-prostitute Roman Catholic alcoholists are 132 % more than the Protestant. This is probably a question of race and stock; it shows, however, that the alcoholism spreads higher in the Roman Catholic than the Protestant communities from which Langho draws its material.* It must indicate to the leaders of the Catholic section that they have a peculiarly difficult material to cope with in the Lancashire district. It is one which is the more difficult, because the Irish district of Liverpool—and it is probably a sample of other Irish immigrant communities in the industrial towns of England—is one of the few instances in which during the last twenty years there has not been a fall in the birth-rate. If, as we believe, extreme alcoholism flows from inferior mental capacity, and such capacity is hereditary, then the introduction of a selective birth-rate is the chief method by which this problem can be approached. The Catholic priest has an intimacy with his flock certainly not excelled, probably hardly equalled, by the minister of any other faith; can the Catholic leaders enlist his services in this the most pressing of eugenic problems—the diminution of hereditary mental defect?

It is worth while considering these results from another aspect. The distinction between the categories of Roman Catholic and Protestant may, as we have noted, be one of race, although ultimately religion itself is a matter of racial temperament. Whether our classification be one of race or not, the actual division, in broad lines, is one of the more excitable, more emotional, and more imaginative natures, as against the more cautious, the more phlegmatic, the more prosaic and quieter spirits. So much may probably be said without any danger of offence. In saying it, however, we are really drawing a division, broad and crude it is true, across a continuously varying characteristic of mankind, and this will apply whether our classification be actually one of race or of religious temperament. We have treated religion accordingly as a continuous variate marking a greater affectibility or excitability of temperament, and have calculated the correlations between it and other characters by two-row table or fourfold table methods with the following results:—

* These are minimum values also, for we have taken Liverpool as our standard for the Langho data. In Manchester, from which much of the Langho material is drawn, Dr. Brown Ritchie informs us that the last quarterly Denominational Summary gave 102,932 and 17,910, Protestant and Catholic children respectively, or in the ratio of 5·75 to 1 instead of 2 to 1.

TABLE IX. Correlations, Religion, Education, Convictions, and Age.

Variates.		No.	Correlation.	Method Employed.	Remarks.
Age and No. of Convictions .		328	$+\cdot289 \pm \cdot034$	Product Moment	(Table A)
Extent of Education and No. of Convictions	F. E.	328	$-\cdot300 \pm \cdot034$	Two Row Table	A fourfold table gave $-\cdot234$ (Table B)
	E. E.	207	$-\cdot445 \pm \cdot037$	Two Row Table	
Extent of Education and Age	F. E.	328	$-\cdot314 \pm \cdot034$	Two Row Table	A fourfold table gave $-\cdot350$ (Table D)
	E. E.	207	$-\cdot094 \pm \cdot046$	Two Row Table	A fourfold table gave $-\cdot146$
Extent of Education and Intensity of Religious Affectibility	F. E.	328	$-\cdot225 \pm \cdot035$	Fourfold Table	(Table F)
	E. E.	207	$-\cdot376 \pm \cdot040$	Fourfold Table	(Table F′)
Intensity of Religious Affectibility and Age		328	$-\cdot082 \pm \cdot037$	Two Row Table	This is insensible; for the sample of 152 it was $+\cdot078$ (Table E)
Intensity of Religious Affectibility and No. of Convictions		328	$+\cdot225 \pm \cdot035$	Two Row Table	(Table C)
Intensity of Religious Affectibility and tendency to prostitution		207	$-\cdot135 \pm \cdot037$	Fourfold Table	See remarks, p. 22.

In every case the correlations are between the increasing values of the variates.

In the face of the smallness of these correlations, it was perhaps hardly worth while testing the partial correlations, yet the values were calculated with the following results:—

Intensity of Religious Affectibility and Number of Convictions for constant Age and constant *Formal* Education . . . . $+ \cdot213 \pm \cdot035$

Intensity of Religious Affectibility and Number of Convictions for constant Age and constant *Effective* Education * . . . . $+ \cdot110 = \cdot046$

Extent of *Formal* Education and Number of Convictions for a constant Age and a constant Intensity of Religious Affectibility . . . . $- \cdot173 \pm \cdot035$

Extent of *Effective* Education and Number of Convictions for a constant Age and a constant Intensity of Religious Affectibility . . . . . . $- \cdot379 \pm \cdot040$

Now these results show that the association between intensity of alcoholism and religious affectibility is little altered by allowing for the formal education; it is about halved by allowing for the effective education; that is to say, the religiously affectible have profited less by their education. On the other hand, the extent of formal education makes some, and the extent of effective education a considerably larger

* This is on the basis of results obtained, where possible, by two-row table methods; if we use, where possible, fourfold table methods the partial correlation is $+\cdot112$, i.e. remains unchanged.

change in the number of convictions for a constant religion at a constant age. Can we therefore say that a profitable education has more influence over alcoholism than religious temperament? Not only can no such result be drawn from such small numbers as we have been able to deal with, but to draw it even from larger numbers would simply be to assert that every association is causation. We cannot take the easy line that the method of reducing extreme alcoholism lies simply in increasing effective education. That assertion would undoubtedly have been made a few years ago when education was looked upon as a panacea for alcoholism, crime, and commercial decadence. But what if both effective educability and alcoholism are the product of mental defect antedating both? The utter incapacity for receptivity which characterizes mental defect leaves not only the mind untrained but the emotions uncontrolled. Is it, then, mental defect rather than want of educational chances which is responsible for the recorded association between intensity of alcoholism and inferior education? This must form the subject of our next inquiry.

(8). *Relations of Mental Defect to Education, Age, and Alcoholism.* The feature of the extreme alcoholists, at any rate of the lower classes, which strikes the inquirer most strongly is the large number of mental defectives to be found among them. At the very outset we emphasized this (p. 18) by showing that the correlation between mental defect and extreme alcoholism lies probably between ·7 and ·8. We have further cited Dr. Branthwaite's general figures, and it will impress the reader still more if we put before him the returns for the last four years from Langho (*Report*, 1910).

TABLE X. MENTALITY OF FEMALE INEBRIATES AT LANGHO.

	1906.	1907.	1908.	1909.	Totals.	Percentages.
Insane	1	3	1	2	7	3·1 %
Very Defective	8	4	3	4	14	6·3 %
Defective	21	33	29	36	119	53·4 %
Normal	11	26	18	28	83	37·2 %
Totals	36	66	51	70	223	

We see from this table that 63 % of these women failed to reach a normal standard of intelligence; they are actually insane or mentally defective.* The great problem of extreme alcoholism may indeed be summed up in the question: Is the large amount of mental defect associated with alcoholism in the female inebriates due to the alcoholism, or does the latter flow from a pre-existing want of mental capacity? Such a table as the above thrusts this problem directly upon the inquirer, and

* There appears to be but slight change going on in this percentage; in 1906 it was 69 %, in 1907 61 %, in 1908 65 %, and in 1909 60 %. These are, however, possibly only variations due to small samples.

yet we find whole treatises on alcoholism which have never faced this fundamental question. Finding feeble mentality associated with alcoholism, their authors invariably attribute it to the alcoholism.

The three fundamental correlations on this point are those between education, age, and mental capacity in alcoholists (Tables G, G′, D, D′, R, and V). We were only able to obtain 207 cases of combined education and mental capacity, and they were thrown into a fourfold table (Tables G bis and G′ bis) of mental capacity, normal and defective, with education, better and worse. We have, of course, results for both formal and effective education, and they provide the following correlations:—

TABLE XI.

Variates.	Method.	No.	Correlation.
Mental Capacity and Extent of Formal Education . .	Fourfold	207	$+\cdot341\pm\cdot038$
Mental Capacity and Extent of Effective Education . .	Fourfold	207 *	$+\cdot644\pm\cdot027$
Extent of Formal Education and Age	Two Row	207 †	$-\cdot314\pm\cdot042$
Extent of Effective Education and Age	Two Row	207	$-\cdot094\pm\cdot046$
Extent of Effective Education and Physique	Fourfold	207	$+\cdot450+\cdot037$
Mental Capacity and Age	Fourfold	207	$-\cdot062\pm\cdot047$

These results are, without being final, very striking. Among alcoholists there is practically no sensible decrease of mental capacity with age. We might have anticipated that if mental defect were a product of alcoholism, the alcoholists would have grown more mentally defective as they grew older. This is not markedly the case; the correlation, having regard to its probable error, is not sensible. While age is related to formal education, a result, as we have indicated, probably due to the older alcoholists having spent their childhood before the days of compulsory education, it is very slightly related to effective education. This is precisely what we should expect if the effective education in the classes from which these alcoholists are drawn depends really on their receptivity in childhood. Formal education is only half as closely related to mental defect as effective education, which is very closely related. It is difficult to understand why this close relationship should hold, if effective education depended on the receptivity of childhood and mental defect were a consequent of adult alcoholism.

If our view be correct, that the high correlation between formal education and age is solely due to the Education Act and not to decay of education as a result of mental defect following alcoholism, we ought to get much the same result for the correlation between age and education for a constant mental capacity. We find:—

* A lower value was obtained by mean-square contingency, but we were only able to make a four × four contingency table, which gave $C_2 = \cdot415$.

† Worked out by a two-row table on 328 cases it was $-\cdot341$ instead of $-\cdot314$. A fourfold table gave the result $-\cdot350\pm\cdot033$. All these are in good agreement.

Extent of *Formal* Education and Age for a constant mental capacity . . . . $= - \cdot 312 \pm \cdot 042$

Extent of *Effective* Education and Age for a constant mental capacity * . . . . $= - \cdot 071 \pm \cdot 047$

The former result shows that mental capacity does not sensibly influence the relation between formal education and age, i. e. confirms the view that the relationship is one of external conditions. The latter result shows that the influence of mental capacity is equally insignificant in its action on the inappreciable relation between effective education and age. Mental capacity decreasing with age is thus not a possible explanation of any relation between education and age. The facts are precisely what we might expect, if mental defect antedated alcoholism; the education of the individual of this class is completed before the age at which alcoholism sets in, and although the estimate of education might be to some extent influenced by the existing condition of the inebriate, yet the grade of education on either basis is in the main determined by conditions and characteristics fully settled before the onset of alcoholism. It is thus all the more remarkable that the correlation of effective education and mental capacity—mental capacity having been asserted to be largely influenced by the alcoholism—should be one of the highest we have reached in this investigation.

We can further illustrate this point by asking what is the correlation of mental capacity and age for a constant grade of education. We find:—

Mental Capacity and Age for a constant extent of formal education . . . . $= + \cdot 050 \pm \cdot 047$

Mental Capacity and Age for a constant extent of effective education † . . . . $= - \cdot 006 \pm \cdot 047$

There is only one conclusion to be drawn from these results, namely, that if the alcoholists be compared grade for grade as regards education, there is no relation whatever between their mental capacity and their ages. Yet if mental defect were a consequent of alcoholism, it should steadily increase with the age of the alcoholist. Nothing of this nature is manifest in the Langho data.

Lastly, let us look at the third partial correlation, the relation between education and mental capacity for a constant age. We should anticipate that if mental capacity is largely affected by length of alcoholism, that the partial correlation co-efficients between mental capacity and education would differ much from their absolute values. We find:—

* If we use the contingency value $\cdot 415$ (see footnote, p. 26) we find for the partial correlation $- \cdot 075 \pm \cdot 047$, sensibly the same value as above.

† Using the contingency value $\cdot 415$ (see footnote, p. 26) we have this partial correlation $= - \cdot 025 \pm \cdot 047$, or again insignificant.

Extent of Formal Education and Mental Capacity
for a constant age . . . . $= + \cdot 340 \pm \cdot 041$

Extent of Effective Education and Mental Capacity
for a constant age* . . . . $= + \cdot 642 \pm \cdot 028$

The absolute values are $+ \cdot 341$ and $+ \cdot 644$.

These results show that the relation between education and mental capacity is for the quite young alcoholist sensibly as intense as for the old alcoholist, or for the whole body of alcoholists. It is impossible to accept this unless we conclude that the mental defect is an antecedent and not a consequent of the alcoholism.

As some confirmation of this view, the correlation between extent of education and mental capacity for a constant intensity of alcoholism (i.e. a constant number of convictions) and a constant age has been worked out. We find:—

Mental Capacity and Extent of Formal Education
for constant age and constant alcoholism . . $= \cdot 296 \pm \cdot 043$

Mental Capacity and Extent of Effective Education
for constant age and constant alcoholism . . $= \cdot 608 \pm \cdot 030$

Thus we may say that the gross correlations between education and mental capacity are ·34 and ·64 for the two kinds of education, and when corrected for age and alcoholism are $\cdot 30 \pm \cdot 04$ and $\cdot 61 \pm \cdot 03$. These differences are scarcely significant, but if we give any weight to them we can only say that the effect of alcoholism does not modify the relation of mental capacity and effective education by more than $\frac{1}{20}$ of its value. It is extremely difficult in the light of such results and those previously indicated to believe that the mental defect in these cases of extreme alcoholism is a consequent of the alcoholism; the only reasonable conclusion is that the mental defect to at least $\frac{19}{20}$ of its value antedates the alcoholism.

(9) *Relation of Civil Status to Prostitution and Intensity of Alcoholism.* We have already indicated that the Langho statistics do not enable us to deal with the problem of want of occupation in relation to alcoholism. If want of occupation leads to alcoholism, it is in a class from which these convicted alcoholists are not drawn. There is only one case of a female alcoholist of independent means recorded in the Langho data, and where no entry of occupation is made, the woman was a prostitute. This introduces a cross-division into our tables, for unpleasant as the recognition may be to some, we have to admit prostitution as a profession, occupation, or calling on the one hand, and when we proceed to deal with a sub-population like that of convicted alcoholists, where 30 % are prostitutes, we are bound on the other hand to treat the prostitute as having a special civil status. What possible meaning can a division into married, widowed, and single bear if we neglect the fact that 17 % of the married, 28 % of the widowed, and 43 % of the single are prostitutes?

* If the contingency value ·415 is used (see footnote, p. 26) the partial correlation is ·412, which again is sensibly the same as the uncorrected value.

The civil status has only social or economic value, when the status of prostitute is excluded or forms so small a percentage of the married, widowed, or single as not to stultify any conclusions drawn from our classification.

TABLE XII. CIVIL STATUS AND EMPLOYMENT. (SEE TABLES H AND I.)

	Employed.	Prostitution.	Independent Means.	Housewives.	Totals.
Married . . .	84	25	—	39	148
Widowed . .	25	10	—	—	35
Single . . .	82	62	1	—	145
Totals . .	191	97	1	39	328

The Langho numbers are too few to break up with any prospect of good result the class of employed, which covers a variety of industrial, domestic, and commercial occupations. With much larger numbers some instructive results might be obtained from such differentiation. Our next table gives the relation of occupation and civil status to age and the intensity of alcoholism. This table at once indicates that not only are the prostitutes the younger women, but that they have the greater number of convictions; the widows alone stand higher in the number of convictions. The single woman has 50 % more convictions than the married woman, and the prostitute

TABLE XIII. OCCUPATION AND CIVIL STATUS. MEAN AGES AND NUMBER OF CONVICTIONS.

Occupation.	Mean Age.	Mean No. of Convictions.	Civil Status.	Mean Age.	Mean No. of Convictions.
Housewife . .	40·00	20·05	Single . . .	31·86	32·07
Employed . .	36·85	28·21	Married . . .	38·68	22·79
Prostitute . .	33·86	31·71	Widowed . .	45·44	35·14
Totals . .	36·39	28·21	Totals . .	36·39	28·21

Standard Deviation of ages = 9·52 years. Standard Deviation of convictions = 28·54 convictions.

50 % more than the housewife. How far this is due to the protection of home, or to the fact that the more mentally defective are more likely to remain single, will be dealt with later. It is clear that if the widows were omitted we should find a negative correlation between age and number of convictions; the widows indeed form an anomalous group, with the highest number of convictions. They are closer to the single women than to the married women, in their number of convictions, and are intermediate in the extent of prostitution. If we deducted from the married women those 17 % who are prostitutes, we find a lower number of convictions, 21·66, for non-prostitute married women. This is very slightly greater than that for housewives; the difference is indeed so slight that it might easily be reversed with more ample statistics; in other words, there is no markedly greater intensity of

alcoholism in married women occupied in their homes than in those who go to outside occupation.

While both as to age and conviction the means of Table XIII have not only apparent, but really significant differences, yet these differences do not mark as high a degree of association as the reader might anticipate, if he paid no attention to the large values for the standard deviations of both age and number of convictions recorded under the table. These lead us in several cases to relatively small correlations. In order to obtain some appreciation of the degree of association involved between prostitution, status, age, and alcoholism, we have divided the inebriates into two groups, the prostitute, and the non-prostitute, which latter includes housewives and employed. This seems fairly reasonable when we examine the age-means, but less satisfactory from the standpoint of convictions. However, the determination of the correlation coefficient did not suggest that this grouping would lessen the association. In the case of civil status we saw less chance of a graded and continuous variate underlying the idea of status than in the case of the factors which impel a woman to professional prostitution. When dealing with age, single, married, widowed, present the only possible order, and a line may be drawn between single and the married together with the widowed; thus marking a distinction between once and never-married. In the case of convictions, however, single and widowed appear to fall more naturally into a single group contrasted with married, the contrast being that of a woman without or with a permanent link to a more or less responsible male. With the above divisions the following correlations resulted :—

TABLE XIV. CORRELATION OF CIVIL STATUS AND EMPLOYMENT WITH AGE AND NUMBER OF CONVICTIONS.

Characteristics.	Correlation.	Method.	No. of Cases.	Remarks.
Prostitution and Convictions	$+\cdot105\pm\cdot037$	Two-row table	328	More prostitution, more convictions
Prostitution and Age .	$-\cdot227\pm\cdot035$	Two-row table	328	More prostitution, less age
Prostitution and Status	$-\cdot413\pm\cdot031$	Fourfold table	328	More marriage, less prostitution
Status and Convictions	$-\cdot217\pm\cdot035$	Two-row table (single and widowed)*	328	More marriage, less convictions
Status and Age . . .	$+\cdot533\pm\cdot027$	Two-row table	328	More marriage, greater age
Convictions and Age .	$+\cdot289\pm\cdot034$	Product moment	328	More convictions, greater age

These correlations indicate, of course, that the single woman and the prostitute have the greater intensity of alcoholism as measured by the number of convictions, but they do not show such an intensity of relationship as would lead us to put great stress on either prostitution or civil status as an important factor in the production of extreme alcoholism. It seemed worth while, however, ascertaining how far civil

* Married and widowed together gave $-\cdot182$, and the correlation ratio (hardly legitimate for a three-rowed table) gave the same value.

status and age contribute to the relationship of prostitution to alcoholism. The value of the correlation between prostitution and convictions when corrected for constant age and civil status is $\cdot 025 \pm \cdot 037$, or on our data is non-significant. In other words the prostitute alcoholist relatively to the non-prostitute is only more alcoholic owing to her age and the fact that she is less frequently married. As far as our material extends we cannot assert that the somewhat greater alcoholism of the prostitute is due to the fact of prostitution; it appears due to the fact that she is differentiated from other alcoholists in age and civil status. Some light may be thrown on this point by examining Tables XV and XVI, which exhibit the relationship of Civil Status and Prostitution to Mental Defect. The mentality is unfortunately only known for the 207 cases; the mean ages are given from the 328 cases.

TABLE XV. Civil Status and Mental Capacity. (See Table Y.)

Status.	Crude Numbers.		Totals.	Percentages.		Mean Ages.
	Normal.	Defective.		Normal.	Defective.	
Single	41	57	98	42 %	58 %	31·86
Married	39 } 51	48 } 58	87	45 % } 47 %	55 % } 53 %	38·68
Widowed	12	10	22	55 %	45 %	45·44
Totals	92	115	207	44 %	50 %	36·39

This table shows that the percentage of mental defect among the married women is somewhat less than among the single women; thus the single women have somewhat more mental defect, just as they have a great number of convictions and are younger.

TABLE XVI. Prostitution and Mental Capacity.

Prostitution and Civil Status.		Crude Numbers.		Totals.	Percentages.		Mean Ages.
		Normal.	Defective.		Normal.	Defective.	
Employed and Housewives	Single	17 } 55	28 } 68	45 } 123	38 % } 45 %	62 % } 55 %	37·47
	Married and Widowed	38	40	78	49 %	51 %	
Prostitutes	Single	24 } 37	29 } 47	53 } 84	45 % } 44 %	55 % } 56 %	33·86
	Married and Widowed	13	18	31	42 %	58 %	
Totals		92	115	207	44 %	56 %	36·39

This table, if we trust to its small numbers, shows some very remarkable points. If, firstly, we consider the problem apart from status there is scarcely any relation between prostitution and mental defect *within the group of convicted alcoholists.* The prostitutes are not the markedly more mentally defective section of the extreme alcoholists. Secondly, however, we note that if status be taken into account, there

is an apparent differentiation with regard to intelligence. The alcoholic prostitutes who are single women are less mentally defective than the alcoholic single women who are not prostitutes, but the married and widowed women who are prostitutes are more mentally defective than the same class who are not prostitutes. In other words, it would appear that employed single mentally defective women and prostitute married mentally defective women become inebriates in larger proportions. Does this signify that the married women who become prostitutes have been largely deserted owing to their mental defect, and that mental defect in the wife does not so readily lead to convicted alcoholism as in the case of the occupied single woman? It must, of course, be remembered that all the statements made are purely relative; in all the categories there is an overwhelming amount of mental defect. The occupied single woman may come more into unguarded contact with the outer world and its alcoholic possibilities, while the prostitute single woman requires more intelligence to follow for any time her difficult calling. We need to know far more about the individual lives of both of these alcoholic classes before any final explanation can be offered, and the problem requires to be considered on far larger numbers. But the suggestions that flow from the Langho data are (i) that the single-women inebriates are on the average younger, more mentally defective, and have had more convictions than the married inebriates, and (ii) the line drawn across the alcoholists between prostitute and non-prostitute does not correspond to any marked distinction between greater and less mental defect.

In the following table we place the correlations of prostitution with a number of other characters for our 207 sample:—

TABLE XVII. Correlation of Prostitution with other Characteristics.

Variates.	Correlation.	Method.	Remarks.
Prostitution and Mentality . .	$-\cdot028 \pm \cdot046$	Fourfold	Non-significant
Prostitution and Good Physical Condition	$+\cdot045 \pm \cdot046$	Fourfold	Non-significant
Prostitution and Good Conduct	$-\cdot250 \pm \cdot043$	Fourfold	Prostitutes are the more troublesome alcoholists
Prostitution and Effective Education	$+\cdot348 \pm \cdot041$	Fourfold	The prostitute has a better education than the non-prostitute

Among alcoholists the prostitute has neither a worse mentality nor physique than the non-prostitute. She has also a better effective education. She is, however, worse behaved or more troublesome in the reformatory. It is difficult in the face of these facts to assert alcoholism as an antecedent to prostitution and mental defect. The greater alcoholism of the prostitute inebriate has not produced a worse physique or greater mental defect.* She is more troublesome although she has had a better

* For a constant alcoholism, i.e. number of convictions, the correlation of prostitution and mental defect $= \cdot000$.

education. We need more data to unravel these complexities, but they smack more of hereditary than environmental products.

(10) *On the Relations of Mental Condition and Physical Condition to the Intensity of Alcoholism.* For these relations we have only the record of 207 cases, so that due regard must be paid to the magnitude of the probable errors. Reasonably reliable results will only be reached when at least 1,000 inebriates have been recorded and tabled in the same way.

Treating first the correlation between age and number of convictions for these 207 cases we find $r = \cdot 288 \pm \cdot 034$; for the 328 cases (see p. 24) it was ·289. The agreement is so good that we have not thought it needful to reproduce the Table.

TABLE XVIII PROVIDES THE RELATIONS BETWEEN THE VARIOUS CHARACTERS.

Variates.	Correlation.	Method.	Remarks.
Number of Convictions and Age	·288 ± ·034	Product Moment	Greater age, more convictions (Table A)
Number of Convictions and Mental Condition	−·267 ± ·034	Two-row Table	More mental defect, more convictions (Table L)
Age and Mental Condition .	−·062 ± ·037	Two-row Table	Greater age, more mental defect (Table R)
Number of Convictions and Physical Condition	−·171 ± ·036	Two-row Table	More convictions, less fit (Table M)
Age and Physical Condition	−·417 ± ·031	Two-row Table	Greater age, less fit (Table S)
Mental and Physical Conditions	·549 ± ·026	Fourfold Table	Mentally defective, less fit (Table O)

Now these correlations show at once some interesting results. (i) The physical condition is very sensibly correlated with age, but (ii) this is not so with the mental condition, which does not get sensibly worse with age. Now we have seen that number of convictions is sensibly correlated with age. Let us remove this influence and see how mentality and physique are correlated with age. We find for the partial correlation co-efficients :—

Correlation of Mental Condition and Age for constant number of convictions . . . . $\rho = + \cdot 016 \pm \cdot 045$.

Correlation of Physical Fitness and Age for constant number of convictions . . . . $\rho = - \cdot 390 \pm \cdot 031$.

The first correlation is sensibly zero, or we see that age—within the limits of the ages of these inebriates, 16 to 69—produces very little effect on the mental condition. We might anticipate that as convictions increase with age we should find a sensible change made, when we allow for convictions. But this is not so; the mental condition changes little with age independently of convictions and hardly more sensibly, if convictions be taken into account. On the other hand, for a constant

number of convictions there is still a very sensible deterioration in physique with age. In other words, for a given intensity of alcoholism, age seems to have little influence on the mental capacity, but a good deal on the physique.* Now let us turn the problem round and ask whether for a given age the number of convictions is highly correlated with the mental capacity or the physique. We find :—

Correlation of Number of Convictions and Mental Capacity for a given age . . . . $\rho = -\cdot 260 \pm \cdot 035$.

Correlation of Number of Convictions and Physical Fitness for a constant age . . . . . . $\rho = -\cdot 059 \pm \cdot 037$.

The latter result seems to indicate that the physique at a given age is not much influenced by the intensity of the alcoholism as measured by the number of convictions. The physical fitness is far more influenced by the advance of age than by the number of convictions. On the other hand, the mental capacity appears little influenced by age, but is more sensibly associated with the number of convictions. Is it to be inferred, then, that alcoholism produces relatively small effect on the physique, † and a much larger effect on the mental condition? Is it not more consonant with reason to suppose that the association between intensity of alcoholism and mental defectiveness does not lie in increased alcoholism producing increased mental defect, but that it is the mental defect which determines the amount of the alcoholism, or the greater mental incapacity which at any rate leads to the greater number of convictions? It seems highly improbable that the alcoholism can deteriorate the mind without first or at the same time deteriorating the body; and this view receives additional confirmation from the fairly high correlation, ·549, which we have found betwen mental and physical fitness in these inebriates, a correlation which if taken for constant age rises to the still higher value of $\cdot 577 \pm \cdot 025$.

(11) *On a Second Method of measuring Alcoholic Intensity.* Thus far we have supposed that the simple number of convictions is a measure of the amount of alcoholic detriment to which the individual has been subjected. It may, however, be suggested that the like number of convictions spread over a large number of years will not measure the same alcoholic tendency as if they were concentrated into a few years. We are not able to accurately measure the number of convictions, nor do we know the age at which the first conviction occurred. But our alcoholists range in age from 16 to 69, and if c be the number of convictions, y the excess in years of the individual over 16, then c/y will be some, if a rough, measure of the concentration of alcoholism. To save the labour of re-working all the correlations on the basis of what is only a rather crude measure, and to determine what influence the concentration of

* An attempt is made below to measure "intensity of alcoholism" rather differently.

† It must be remembered that the physique is here measured by the test of fitness to do hard work when in the inebriate reformatory, and not by the condition when in a state of alcoholism. It is of much interest to note that physical fitness is fairly highly correlated with effective education (·450); again we find a pre-alcoholic character associated closely with one supposed by the writers on this subject to be largely controlled by the intensity of the alcoholism.

alcoholism has, approximate formulae were worked out expressing the correlation of $u = c/y$ in terms of statistical constants already calculated.

Clearly if a be the age, a bar denote as usual a mean value, and v a coefficient of variation :—

$$\bar{y} = \bar{a} - 16, \quad \sigma_y = \sigma_a, \quad v_y = \sigma_y/\bar{y} = \sigma_a/(\bar{a} - 16),$$

and approximately

$$\bar{u} = \frac{\bar{c}}{\bar{y}}(1 + v_y^2 - v_y v_c r_{yc}), \quad v_u^2 = v_c^2 + v_y^2 - 2 v_y v_c r_{yc}$$

where accurately $r_{yc} = r_{ac}$.

Let z be any character, which we may put either $= m$ the mental capacity, or $= p$ the physical fitness. Then

$$r_{uz} = (v_c r_{cz} - v_y r_{az})/v_u,$$
$$r_{ua} = (v_c r_{ca} - v_y)/v_u,$$
$$r_{uc} = (v_c - v_y r_{ac})/v_u.$$

The partial correlations of the character z with the age and number of convictions for a constant u will be given by :

$${}_u\rho_{za} = \frac{r_{za} - r_{uz} r_{ua}}{\sqrt{1 - r_{uz}^2}\,\sqrt{1 - r_{ua}^2}},$$

$${}_u\rho_{zc} = \frac{r_{zc} - r_{uz} r_{uc}}{\sqrt{1 - r_{uz}^2}\,\sqrt{1 - r_{uc}^2}}.$$

These may be expressed in terms of the original co-efficients as follows:—

$${}_u\rho_{za} = \frac{v_c(r_{az} - r_{cz} r_{ca}) + v_y(r_{cz} - r_{az} r_{ac})}{\sqrt{1 - r_{ac}^2}\,\sqrt{v_c^2(1 - r_{cz}^2) + v_y^2(1 - r_{az}^2) - 2 v_c v_y (r_{ac} - r_{az} r_{cz})}}$$

$${}_u\rho_{zc} = \frac{v_y(r_{cz} - r_{az} r_{ac}) + v_c(r_{az} - r_{ac} r_{zc})}{\sqrt{v_c^2(1 - r_{cz}^2) + v_y^2(1 - r_{az}^2) - 2 v_c v_y (r_{ac} - r_{az} r_{cz})}\,\sqrt{1 - r_{ac}^2}}$$

$= {}_u\rho_{za}$, as we should *a priori* anticipate.

Hence all we need determine for these partial co-efficients are :—${}_u\rho_{ma} = {}_u\rho_{mc}$, and ${}_u\rho_{pa} = {}_u\rho_{pc}$.

The following table gives the value of the chief numerical constants needful :—

TABLE XIX.

	Mean.	Standard Deviation.	Coefficient of Variation.
a	$\bar{a} = 35{\cdot}82$	$\sigma_a = 9{\cdot}359$	$v_a = {\cdot}2613$
y	$\bar{y} = 19{\cdot}82$	$\sigma_y = 9{\cdot}359$	$v_y = {\cdot}4722$
c	$\bar{c} = 28{\cdot}34$	$\sigma_c = 15{\cdot}828$	$v_c = {\cdot}5585$
u	$\bar{u} = 1{\cdot}64$	$\sigma_u = 1{\cdot}0152$	$v_u = {\cdot}6190$

TABLE XX. CORRELATIONS.

m	$r_{um} = -{\cdot}1935$	$r_{ua} = -{\cdot}5031$	$r_{uc} = +{\cdot}6826$
p	$r_{up} = +{\cdot}1638$	${}_u\rho_{ma} = {}_u\rho_{mc} = -{\cdot}1875$	${}_u\rho_{pa} = {}_u\rho_{pc} = -{\cdot}3918$
	${}_u\rho_{mp} = +{\cdot}6003$	${}_a\rho_{mu} = -{\cdot}2605$	${}_a\rho_{pu} = -{\cdot}0586$
	${}_a\rho_{mp} = +{\cdot}5768$	${}_c\rho_{mu} = -{\cdot}0159$	${}_c\rho_{pu} = +{\cdot}3845$

The results for ${}_a\rho_{mu}$, ${}_a\rho_{pu}$, ${}_c\rho_{mu}$, ${}_c\rho_{pu}$ should, of course, be identical—the last two with the signs changed—with those found for ${}_a\rho_{mc}$, ${}_a\rho_{pc}$, ${}_c\rho_{ma}$, and ${}_c\rho_{pa}$ on p. 33. The excellent accordance between the results shows us that the approximate formulae are reliable.

The results as a whole, however, only add slightly to our knowledge, and this in the following manner:

(i) The average annual number of convictions is 1·7, and the distribution of these annual numbers of convictions is clearly very skew, i. e. σ_u is a large relative to $\bar{u}$, so that the range of variation is largely on the excess side of the mean.

(ii) The relation between mental condition and the annual number of convictions is less close than the relation between mental condition and the total number of convictions; the relation between physical condition and annual number of convictions is *positive*, whereas the relation between physical conditions and total number of convictions is negative. The only explanation that we can put upon these facts is that the total number of convictions is more important than the period over which they are spread; if that period be short, it means that the age of the inebriate is less and accordingly the physique better, hence the positive correlation. Both correlations seem to suggest that the total amount rather than the concentration of the alcoholism is the important factor.

(iii) The relation of physical condition to age is less for a constant annual number of convictions than for a constant total number of convictions, being only about half as much.

(iv) Finally the relations between annual number of convictions and age and number of convictions are noteworthy. If the annual number of convictions were a vital factor of alcoholism, we should expect it to have little relation to age, yet we see that when the age is great, the annual number of convictions is small, and when the age is low the annual number is great. Again we should not expect if the annual number of convictions were the essential variate of alcoholism, that it would be highly correlated as it is with the total number of convictions. In fact the values for r_{ua} and r_{uc} are precisely of the character we should anticipate, if there were little dependence of c on a, i. e. if r_{ac} were small; for in this case the correlations of the ratio c/a with a and c would take considerable negative and positive values,—thus satisfying the theory of spurious correlation.

It is quite possible that, if we had more elaborate records giving the age at onset of the alcoholism and the exact number of convictions, the correlation of the number of convictions and the years of alcoholism would be far higher, and accordingly the annual number of convictions might be a valuable measure of the intensity of the alcoholism. As it is, we do not know the age at onset, nor the true number of convictions, and our approximation to its value seems for the reasons given above to be less significant than the crude number of convictions.

The correlation given above (${}_a\rho_{pu}$) shows that for a constant age the number of

convictions per year has no sensible effect on the physique. There is, however, quite a sensible correlation between mental defect and the number of convictions per year for a constant age (${}_a\rho_{mu}$). This result is in agreement with the fact that 78 % of the women at Langho with an average number of 27 convictions against them are physically fit for hard work,* while 63 % of women with an average number of 33 convictions against them are mentally defective, or practically incapable, even when sober, of guiding their conduct. We still face the problem of whether this large proportion of mental defectives—immensely greater than we find in the general population—is due to the alcohol, or whether it is the pre-existing mental defect which leads to the alcoholism, and which possibly is to some extent exaggerated by it.

We cannot profess to answer this problem finally on the data of the present section. It probably can only be answered when we have ample records relating to those inebriates who have been recommitted to reformatories at considerable intervals. But certain points should be kept in view even if the judgement be suspended.

(i) Mental defect is, in many stocks at least, of an hereditary character. It is further interchangeable in heredity with a variety of other degeneracies, e. g. insanity, alcoholism, &c.

(ii) While alcoholism is often associated in the same individual with either insanity or mental defect, it occurs also in individuals of insane and mentally defective stocks, who are not themselves either insane or mentally defective.

(iii) While mental defect is highly correlated with physical unfitness, we do not find, as we should expect if mental defect were caused by the alcoholism, a physical deterioration going on at the same rate.

(iv) A large proportion of criminals (45 %) are mentally defective, and the number of convictions in that case also is correlated with the mental unfitness.

We hardly speak of crime producing mental defect, but of the mental defect leading to the criminality; it appears not improbable that alcoholism as measured by number of convictions is of the same character; both are due to the want of will-power and of self-control, which flow from the absence of mental balance, i. e. from the mental defect, rather than themselves productive of it.

The investigations given in this section are far too slender to demonstrate the views indicated, but they are far from opposed to them, and a study of the pedigrees of degenerate stocks certainly supports this interpretation. From this view-point want of education is not a source of alcoholism, nor is mental defect its product. It is the excitable, emotional, mentally uncontrolled nature refusing education or not assimilating it which becomes alcoholic, and the more mentally defective it is,

* The actual proceeds of the industrial occupations of the 70 women for the year 1909 at Langho were £1,478, or an average of £21 apiece, if we reckon it on the total, whether physically fit or not for hard work. This result speaks not only well for the management, but for the relative physical fitness of the inmates.

the more alcoholic it will be. Only when the inebriate reformatories are made national laboratories for studying on a uniform system the present and the past histories of the alcoholic, shall we have sufficient material upon which true answers to the problems suggested can be reached.

(12) *On the Relation of Conduct to Alcoholism and Mental Defect.* One of the characters recorded in the reformatory is that of behaviour, and we believe that much might be learnt from a somewhat fuller consideration of the temperament and temper of the inebriates. A full investigation of these points would throw much light on the mental traits of the women who ultimately become inebriates. As a matter of fact, the bare record of conduct in the reformatory shows much of great interest; thus* only 9 % of the women are really troublesome, although only 71 % are classed as "well-behaved", the remaining 20 % falling into the class of "manageable", which we interpret as meaning that these women can be managed with tact, although they need special attention. The smallness of the category of "troublesome" and "very troublesome" cases has compelled us to make only the two categories of "well-behaved" and "not well-behaved", but when the records cover thousands of cases, not a couple of hundreds, this must, and can easily be, modified.

Tables N, Q, and T give the material for a judgement as to the inter-relationships of conduct with other characters.† First as to age and convictions, we have the following results (see Tables N and T):—

TABLE XXI.

	Well-behaved.	Manageable.	Troublesome.
Mean Ages	37·03	33·16	32·18
Mean Number of Convictions . .	25·78	35·07	34·05

It is thus clear that both in age and number of convictions the "manageable" differ much more from the "well-behaved" than they do from the "troublesome". The "troublesome" and the "manageable" are 4 to 5 years younger women, and they have had 30 % to 40 % more convictions than the well-behaved. We are thus justified in putting these two classes together, and we see that the women who are "well-behaved" are rather the older women and those with a smaller police-court record. It may be said, and is very likely to some extent true, that they have had longer experience of prison and reformatory discipline and that this accounts for their conduct. This would not, however, account for their fewer convictions. If, however,

* Cf. the numbers given on p. 10, footnote, for longer series.

† It must be remembered that, as in the case of the mental and physical conditions, this is conduct when out of reach of alcohol. In judging the conduct of the inebriate in practical life outside the reformatory we are too apt to compare conduct before or in the early stages of alcoholism with that of the individual in a chronic state of alcohol. To judge the deterioration produced by alcohol, we must judge conduct before and after in a state of sobriety.

a somewhat greater factor of self-control be the source of their better conduct, this would explain their smaller number of convictions. The lessening of the intensity of emotions and sensual passions with age, a lessening which renders the reformatory discipline less irksome, would in all probability sufficiently account for the greater age of the "well-behaved".

We now turn to the correlations of conduct with other characters. (See Tables T, N, P, P bis, Q, Q bis.)

TABLE XXII.

	Correlation.	Method.	Remarks.
Good Conduct and Age	$+\cdot 269 \pm \cdot 034$	Two-row Table	Well-behaved, older (Table T)
Good Conduct and Number of Convictions	$-\cdot 206 \pm \cdot 035$	Two-row Table	Well-behaved, fewer convictions (Table N)
Good Conduct and Mentality	$+\cdot 486 \pm \cdot 028$	Fourfold Table	Well-behaved, less defective (Table P bis)
Good Conduct and Physique	$-\cdot 256 \pm \cdot 035$	Fourfold Table	Well-behaved, less fit (Table Q bis)
Good Conduct and Education	$+\cdot 363 \pm \cdot 040$	Fourfold Table	Well-behaved, better educated

Now these results as they stand are of very considerable interest. The well-behaved women are the older, the less-often convicted, the better educated, the more intelligent, and the feebler in physique; the troublesome women are the younger, the more often convicted, the more mentally defective, but the physically stronger.* These conclusions are the more instructive because we have found a very considerable correlation between mental and physical fitness in these inebriates. Yet in percentages we see from Tables Q bis and P bis that while 25 % of the "well-behaved" are unfit for hard work, only 13 % of the "troublesome" are incapable of it; on the other hand only 46 % of the "well-behaved" are "mentally defective", while 78 % of the "troublesome" are thus deficient. This remarkable fact—that it is the physically fitter and younger group of women who show the greater intensity of alcoholism as measured by number of convictions, behave worse, and are more mentally defective—seems to emphasize the view that the extreme forms of alcoholism are the result of a strong physical nature under little mental control, and that defective mentality is not so much the outcome as one of the chief factors contributing to extreme alcoholism.

(13) *Conclusions.* The writers of this paper are fully conscious of the slenderness of their data; they have themselves stated that many of their conclusions are probabilities or suggestions rather than demonstrations. They will no doubt be upbraided with publishing anything at all, either on the ground that what they are dealing with is "crude and worthless material" or that as "mathematical outsiders"

* The prostitutes, as we have seen, are the younger and the more troublesome, but a cross-current is seen when we note that they are not more mentally defective and are better educated.

they are incapable of dealing with a medico-social problem.* They, on the contrary, believe that the material collected by Dr. Gill at Langho is of very great value and on that very account want to see it immensely increased in volume and fuller in detail.† The chief object indeed in the publication of this paper is to draw attention to the need for the publication of detailed accounts of each individual inebriate. The great work recently undertaken by H.M. Prison Commissioners in the study of the physique, mentality, and family history of the criminals in their charge ought to be extended to the inebriates and ultimately to the insane. The prisons, the asylums, and the inebriate reformatories form in combination a great national laboratory for the study of those degeneracies upon the limitation of which the welfare of society so largely depends. We do not want more emotional writings or more verbal disquisitions about the criminal, the insane, and the alcoholic. We need above all things to create a school with the requisite social, medical, psychological, and statistical training, which will set to work and study their physique, their mentality, their family history, and their past environments. In this matter we are sadly behind even a poor land like Spain. In Madrid attached to the University is a school of criminal anthropology and psychology, and there the medical prison officer and the prison governor must graduate before entering on their professional careers. The prisons of Madrid are open to the professors and their students, of course under special regulations, and even as the wards of the hospitals provide clinical material for the academic study of medicine and surgery, so the prison becomes a laboratory for the study of criminology. The inebriate reformatory ought in the same way to be regarded not only as a place for the seclusion and possibly the reformation of the alcoholist, but as a laboratory where material may be collected, upon which a really scientific knowledge of alcoholism may be based. At present there is much declamation, endless prejudgement, and, with a few noteworthy exceptions, little genuine study of alcoholism; the very data upon which sound judgements could be based are either wanting, or, if existing, defective in character, and too few to give final conclusions.

We are told, and we believe it to be true, that the record of past convictions is extremely imperfect. The women with whom we are here dealing are largely migratory,

* One critic of the recent Eugenics Laboratory memoir on alcoholism, who describes himself as a Fellow of the Royal Statistical Society, apparently considers that our attempt to study alcoholism statistically is a sign of our "drug indulgence." He writes: "that the educated man and the scientist is as prone as any other to become the victim (often the unconscious victim) of his prejudices. When these prejudices centre round a drug like alcohol which entwines itself [*sic*!] into the sensuous side of man's nature he will in defence thereof make shipwreck of both the facts of science and the methods of science, and devote himself to the defence of his drug indulgence, even in what is called moderation, by perpetrating every form of fallacy, inaccuracy, and distortion"; he continues by telling us that it is only prejudice and passion which can extract proofs out of such material as we have used, and concludes by citing Pope's "The ruling passion conquers reason still." It would be franker if this gentleman stated his conviction that we must be inebriates!

† The large admixture of Irish at Langho may also weight certain features of the analysis.

and may have different names and separate police records in several localities. This renders it as hard to obtain a record of the extent of the worst type of inebriety as it is to ascertain the total number of persons in the country who have been at any time of their life certifiably insane. As in the case of the insane, so in the case of confirmed inebriety, a central registry with an index number for each individual ought to be established. And if need be, the register should be based on a finger-print identification. If a woman who is certified to have been convicted 12 times may really have 40 convictions against her, it is certainly worth some expense and trouble to have this knowledge with accuracy. Women who have been convicted 50 to 100 times are assuredly, from the standpoint of society, as needful of registration and identification as any habitual criminals. They are as great a power for ill in the land, and their careful study is as urgent and as valuable.

We are fully aware of the good work that has been done by several reformatory directors, but each of these men comes only in touch with a relatively limited material; their observations need extending, standardizing, and pooling, and this can only be done by a central authority. A standardized schedule of observations to be made and points to be recorded would not hinder the individual from following up special and personal lines of inquiry, but it would produce adequate material for safe statistical conclusions on many simple points. A most desirable addition to the staff of each reformatory would be a trained social worker, a volunteer, if it cannot be otherwise, but by preference a paid educated or even medically qualified woman,* who would, like the similar assistants now attached to the medical officers of health, investigate the past environment and the family history of each case. It is only when the data gathered by such inquiries are available in mass that we shall be able to settle finally what are the causes of alcoholism, and how it can best be handled.

Looking at the Langho data dealt with in the course of this paper, we can only give, under reservation, the following suggestions:—

(i) If intensity of the alcoholic mania be measured by the number of convictions, there appears for constant age little relation between alcoholism and physical fitness.

(ii) There is a sensible relation between alcoholism and poor education and alcoholism and mental defect. We consider it probable, for reasons stated above, that the alcoholism is not due to the poor education, nor is it to any marked extent

* The poorer districts of our large towns, where such assistants would largely have to work, are becoming more and more familiar, and resent less and less the inquiries of such *women* workers, even when they touch very intimate details of domestic economy. There are already medical officers of health, who ascertain from their women assistants whether in the case of each baby born a dummy teat is used, and where the supply of milk is kept, to say nothing of the cleanliness and orderliness of the parents and the ventilation of their homes. There is an immense field of work for women in the problems of social hygiene. It is becoming more and more often paid work and a specialized academic training, in part, but not wholly, medical must be developed to meet it.

productive of the mental defect, but the want of will-power and self-control, associated with mental defectiveness, is itself the antecedent of the poor education and of the alcoholism.

(iii) The physically stronger, judged from religion (or race) the emotionally more excitable, and, judged from intelligence the more mentally defective, tend more to alcoholism, and give, when sober in the reformatory, most trouble.

(iv) If alcoholism is the product of the association of emotionally excitable, physically strong natures with want of mental balance, we see that it is rather the hereditary than the environmental factor to which in alcoholism, as in criminality and insanity, the first attention must be paid. It is a study of stock, not of environment, which must give us the real clue to the treatment of alcoholism.

Whether we suppose the 63 % of mentally defective persons among these inebriates to be the source or the product of the alcoholism, one fact is clear, the reformatory does not restore them to mental efficiency, nor in the great bulk of cases give them the power to control to social advantage their own lives.

This is well illustrated by some details Dr. Gill gives as to his inmates. In 1908–9 38 women were released (*Report*, March, 1909). Of these 8 were doing well when last heard of, but even of these the post-reformatory history must only have been known for a very short period. 1 relapsed once, 1 was released as she was suffering from cancer, 1 ill when discharged was sent to a workhouse and subsequently relapsed, 2 were morally insane on reception, 2 were very feeble-minded but not certifiably insane, 1 became insane after discharge but 'kept out of trouble' while at liberty, 1 was epileptic and mentally peculiar, 1 suffered from chronic rheumatism and was practically unfit to earn her livelihood, 20 were feeble-minded in a less degree, but were obviously below the normal mental standard of working-class women. Of the 118 women released, 1906–8 (*Reports*, 1907, 1908, 1909), we are told that 45 relapsed, 1 was convicted for a crime other than drunkenness, 2 were insane, 24 could not be traced, and 46 were reported as doing well. In other words, in round numbers within an average of *two* years from their discharge, 41 % were again social wrecks,* 20 % had disappeared,† i. e. probably migrated to another district where their relapse would not involve, owing to ignorance of their previous history, immediate recommittal, and 39 % were reported on a very brief experience as doing well.‡ Even if those 39 % were really reformed, the problem of the

* Dr. Gill (*Report*, 1909, p. 16) says: "I have included as relapsed all those women who are reported to have been seen under the influence of drink, although they have not been convicted of any offence, and also one convicted of stealing, although drunkenness was not alleged."

† This 61 % of probable failures comes very near the 63 % of mental defectives.

‡ It is again a case of our need for further knowledge. Many will call to mind cases where an inebriate after treatment has done well for 3, 5, or even 10 years, and then the self-control has again failed. Some statistics due to Mr. R. J. Parr, Director of the Society for Prevention of Cruelty to Children, are cited by Dr. Branthwaite in his 1908 *Report*. Mr. Parr obtained particulars of 133 cases admitted to Reformatories between April 1, 1902, and March 31, 1904, *whom he had watched for one*

remainder is not solved by their brief detention in the reformatory. They have clearly not the mental power to control their course in life; they cannot become sober, hardworking women. They return to their former mode of life, and are sources of disease and social demoralization. If they become mothers, their children inherit their mental deficiency, and increase that section of the population which is reared at the expense of the State. In the reformatory the great bulk of these inebriates are well-behaved or manageable, and capable of doing a very fair amount of remunerative work. They are kept out of mischief and hindered from multiplying their kind. It appears to us that the problem of the inebriate woman, the problem of the lowest type of prostitute, and the problem of the habitual criminal are closely one with the treatment of the mentally defective. And we think there is considerable evidence to show that the mental defect of the female inebriate and of the male criminal is not the product of alcohol or of crime: it is the mental defect of the child still handicapping the adult. The segregation of the mentally defective child of both sexes is the first step in the effective treatment of both alcoholism and criminality; we have to meet want of mental control in its hereditary origin. We have tried reform, and we have tried punishment; we have tried teaching, and we have tried preaching; it remains to try segregation.

The importance of segregation and regulation from the age of puberty becomes manifest, if we consider the fertility of these inebriates. In his 1905 *Report*,* Dr. Branthwaite gives an account of 352 women. Of the single women, 81·6 % were said to be childless, but the returns for these women must be very doubtful. Of the 193 married and widowed women, 23 % were childless. Prostitution probably accounts largely for the excess of childless women among both single and married. But the average number of children born to each married woman, excluding the childless, was 9·2, and to each widow, the childless excluded, 4·5! More moderate results are given for 846 married and widowed women (no longer, unfortunately, separated) for the years 1905–8, the average number of children born being 5·6, the childless women excluded, of whom there were 19·5 %. When it is remembered that 5 to 6 children is high for the *completed* families of the *better* artisan classes, and that the average age of these women is about 36 (see p. 21), so that their families are not completed, we see how great is the fertility of the married inebriates. The death-rate, however, is very great. While in Manchester the nett family of the sober is 4·3, and of the drinking mother 4·2, the death-rates being 26·5 % and 33·8 % respectively, with these extreme alcoholists the nett family is 3·1 and the death-rate 45·6 %. The death-rate, high as it is, does not, however, provide the social protection

year or longer after discharge. Of these 5 died or were sent to an asylum, of 15 he had no record, 54 relapsed, and 59 were reformed. This gives 44 % reformed for a period of *one year or longer*, but it is expressly stated that these were the inebriates with decent homes and few convictions. This compares closely with Dr. Gill's 39 %, also on a brief experience of after-history.

* Table XV of *Report*.

which complete segregation of the mentally defective child would achieve. The 1,291 *single*, married, and widowed women, 63 % of whom were mentally defective, had 2,187 living children to whom they would largely hand on their anomalies.

Should the reader of this memoir have read a previous memoir * on alcoholism issued by the Galton Laboratory, he may at first sight be puzzled by an apparent contradiction. In that case no close relation was found between mental defectiveness in the children and alcoholism in the parents. Here a close relationship is found between mental defect and alcoholism, and on the basis of it segregation of the mentally defectives advocated because of the hereditary character of such defect. We can only state results as they flow from our data, and then seek an explanation of any apparent discrepancy. In the Edinburgh and Manchester samples we found no excesses of mental defect in the children of the alcoholic; in the Langho data we find excess of mental defect in the alcoholists themselves, and anticipate it in their offspring. What is the probable explanation of this apparent discrepancy? We think there is little doubt of its true explanation. The mentally defective become *extreme* alcoholists, inebriates in constant conflict with the police because the mental defect is antecedent to their alcoholism. But because the bulk of the mentally defective become criminal or alcoholic, it does not follow that every alcoholist is mentally defective, and will breed mentally defective children. The extreme female cases of alcoholism which lead largely to the reformatory are to a great extent the product of mental defect, but these cases form something under $\frac{1}{1000}$ of the female population, and have a large contingent of non-childbearing women. On the other hand, intemperate mothers form 15 % of our working-class population sample in Manchester and 36 % in Edinburgh. The 0·1 % of convicted inebriates does not affect returns based on these large percentages of those that drink without being convicted inebriates. In other words, there are other sources of a taste for alcohol beside mental defect; and as we have seen in the case of Edinburgh, the alcoholic parents, as a whole, follow the trades requiring greater intelligence and greater strength. It is one of the difficulties of much temperance reform that, finding mental defect associated with and probably the cause of the extreme cases of alcoholism, and in such cases undoubtedly followed by mental defect in the children, the supporters of the movement have asserted that parental alcoholism leads to mentally defective children, whereas the alcoholism is probably as much the product of the mental defect in these extreme cases as the mentally defective children are. We do not propose the segregation of all extreme cases of alcoholism, but the segregation of the mentally defectives, as they form one, if not the principal, source of such extreme cases. Further, we think it unreasonable that facts relating to perhaps 0·1 % of convicted inebriates should be stated as applying to the whole alcohol-using section of the community.

* *A First Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring.* Second Edition, 1910, Dulau & Co.

As to the remedy for extreme cases which we propose, only those who make a fetish of personal liberty—in this case largely the liberty to annoy, if not to demoralize, their neighbours—can take objection to Dr. Gill's conclusion in his last *Report*: "That public decency and morality, economy, humanity, and many other reasons call for the segregation of inebriates" (*Report*, 1909).

But this segregation on any large scale is, we hold, only a temporary necessity. With the segregation of mentally defective children the number of certified inebriates to be segregated would grow less and less year by year, and those left having more normal intelligence would be those who were more susceptible of the permanent reform, which it was originally hoped would flow in the bulk of cases from a temporary seclusion.

APPENDIX OF TABLED DATA

TABLE A. AGE AND NUMBER OF CONVICTIONS.

No. of Convictions.	Age.																		Totals.
	16–18.	19–21.	22–24.	25–27.	28–30.	31–33.	34–36.	37–39.	40–42.	43–45.	46–48.	49–51.	52–54.	55–57.	58–60.	61–63.	64–66.	67–69.	
1–5	—	2	—	5	2	5	2	3	3	1	2	2	2	—	—	—	—	—	29
6–10	—	7	5	9	7	8	8	4	3	6	2	3	2	—	1	—	—	—	65
11–15	1	2	4	6	6	—	7	9	1	5	2	1	1	—	1	—	—	—	46
16–20	—	—	4	5	9	6	4	1	4	1	2	1	2	—	—	—	—	—	39
21–25	—	1	2	3	6	2	2	4	3	—	—	1	2	1	—	—	—	—	27
26–30	—	—	—	4	2	2	3	3	3	1	2	2	—	—	—	—	—	1	23
31–35	—	—	—	5	3	2	1	2	1	1	—	—	—	—	1	—	—	—	16
36–40	—	—	—	1	1	—	1	1	1	1	—	—	—	1	—	—	—	—	7
41–45	—	—	—	—	1	4	2	3	4	1	—	—	1	—	—	1	—	—	17
46–50	—	1	—	—	—	—	1	1	1	—	1	1	1	—	—	—	—	—	7
51–55	—	—	—	2	—	2	3	—	1	1	3	—	—	—	—	—	—	—	12
56–60	—	—	—	—	—	—	1	—	2	1	—	—	—	—	—	—	—	—	4
61–65	—	—	—	—	1	2	1	—	1	—	—	2	—	—	—	—	—	—	7
66–70	—	—	—	—	—	—	3	—	1	2	—	—	—	—	—	—	—	—	6
71–75	—	—	—	1	1	1	—	—	1	—	—	—	—	—	—	—	—	—	4
76–80	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	2
81–85	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	2
86–90	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2
91–95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
96–100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
101–105	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
106–110	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	2
111–115	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
116–120	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
121–125	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
126–130	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	2
131–135	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
136–140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
141–145	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
146–150	—	—	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	3
151–155	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
156–160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
161–165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Totals .	1	13	15	41	39	35	43	32	34	22	16	14	12	4	3	2	—	2	328

TABLE B. Formal Education and Number of Convictions.

TABLE C. Religion and Number of Convictions.

No. of Convictions	Formal Education. Good.	Fair.	Elementary.	Imperfect.	Poor.	Defective.	Bad.	Nil.	Totals.	Religion. Roman Catholic.	Protestant.
1–5	5	2	19	1	1	—	—	1	29	12	17
6–10	3	1	56	2	—	1	—	2	65	24	41
11–15	—	1	37	4	—	2	—	2	46	21	25
16–20	5	1	28	1	1	2	—	1	39	17	22
21–25	1	—	20	1	—	1	1	3	27	17	10
26–30	1	1	18	2	—	—	—	1	23	11	12
31–35	—	1	9	3	—	1	1	1	16	9	7
36–40	—	1	4	—	—	1	—	1	7	5	2
41–45	1	—	13	—	—	—	—	3	17	12	5
46–50	—	—	5	1	—	—	—	1	7	5	2
51–55	—	—	11	—	—	—	—	1	12	6	6
56–60	—	—	3	—	—	—	—	1	4	3	1
61–65	—	—	6	—	—	—	—	1	7	5	2
66–70	—	—	3	1	—	1	—	1	6	2	4
71–75	—	1	2	—	—	1	—	—	4	3	1
76–80	—	—	1	—	—	—	—	1	2	1	1
81–85	—	—	—	1	—	—	—	1	2	2	—
86–90	—	—	2	—	—	—	—	—	2	1	1
91–95	—	—	—	—	—	—	—	—	—	—	—
96–100	—	—	—	—	—	—	—	—	—	—	—
101–105	—	—	1	—	—	—	—	—	1	1	—
106–110	—	—	2	—	—	—	—	—	2	2	—
111–115	—	—	—	—	—	—	—	—	—	—	—
116–120	—	—	—	1	—	—	—	—	1	1	—
121–125	—	—	1	—	—	—	—	—	1	1	—
126–130	—	—	1	—	—	—	—	1	2	1	1
131–135	—	—	1	—	—	—	—	—	1	1	—
136–140	—	—	—	—	—	—	—	—	—	—	—
141–145	—	—	—	—	—	—	—	—	—	—	—
146–150	—	—	1	—	—	—	2	—	3	2	1
151–155	—	—	—	—	—	—	—	—	—	—	—
156–160	—	—	1	—	—	—	—	—	1	—	1
161–165	—	—	—	—	—	—	—	1	1	1	—
Totals .	16	9	245	18	2	10	4	24	328	166	162

TABLE D. Formal Education and Age.

Formal Education.	Age. 16–18.	19–21.	22–24.	25–27.	28–30.	31–33.	34–36.	37–39.	40–42	43–45.	46–48.	49–51.	52–54.	55–57.	58–60.	61–63.	64–66.	67–69.	Totals.
Good . . .	—	—	—	1	3	1	3	3	2	1	1	—	1	—	—	—	—	—	16
Fair . . .	—	2	—	2	—	—	—	1	2	1	—	—	1	—	—	—	—	—	9
Elementary .	1	10	13	33	32	28	37	22	23	12	13	10	6	1	1	2	—	1	245
Imperfect .	—	—	—	2	1	2	1	2	2	4	—	2	1	—	1	—	—	—	18
Poor . . .	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Defective . .	—	—	—	1	1	2	2	1	—	1	—	—	1	1	—	—	—	—	10
Bad . . .	—	—	—	1	—	—	—	—	1	—	2	—	—	—	—	—	—	—	4
Nil	—	—	1	1	2	2	—	3	4	3	—	2	2	2	1	—	—	1	24
Totals . .	1	13	15	41	39	35	43	32	34	22	16	14	12	4	3	2	—	2	328

TABLE B′. Effective Education and Number of Convictions.

No. of Convictions.	Effective Education. Superior Education.	Can read and write well.	Can read and write imperfectly.	Can neither read nor write.	Totals.
1–5	2	5	5	2	14
6–10	5	8	12	9	34
11–15	—	9	10	7	26
16–20	1	11	22	1	35
21–25	—	2	11	5	18
26–30	1	6	8	2	17
31–35	—	2	10	2	14
36–40	—	1	2	—	3
41–45	—	2	6	2	10
46–50	—	—	3	1	4
51–55	—	—	6	2	8
56–60	—	—	2	1	3
61–65	—	—	3	2	5
66–70	—	—	2	1	3
71–75	—	—	2	—	2
76–80	—	—	1	—	1
81–85	—	—	—	1	1
86–90	—	—	1	1	2
91–95	—	—	—	—	—
96–100	—	—	—	—	—
101–105	—	—	1	—	1
106–110	—	—	1	—	1
111–115	—	—	—	—	—
116–120	—	—	—	1	1
121–125	—	—	—	—	—
126–130	—	—	1	—	1
131–135	—	—	1	—	1
136–140	—	—	—	—	—
141–145	—	—	—	—	—
146–150	—	—	—	1	1
151–155	—	—	—	—	—
156–160	—	—	—	1	1
Totals .	9	46	110	42	207

TABLE D′. Effective Education and Age.

Age.	Effective Education. Superior Education.	Can read and write well.	Can read and write imperfectly.	Can neither read nor write.	Totals.
16–18	—	—	1	—	1
19–21	—	2	4	2	8
22–24	—	2	7	2	11
25–27	—	8	12	6	26
28–30	1	7	18	—	26
31–33	1	8	10	3	22
34–36	3	5	18	5	31
37–39	1	6	9	5	21
40–42	2	1	12	6	21
43–45	1	2	7	—	10
46–48	—	1	6	2	9
49–51	—	2	2	3	7
52–54	—	1	3	4	8
55–57	—	—	—	1	1
58–60	—	—	—	2	2
61–63	—	—	1	1	2
64–66	—	—	—	—	—
67–69	—	1	—	—	1
Totals .	9	46	110	42	207

TABLE E. Religion and Age.

Religion.	Age.																		Totals.
	16–18.	19–21.	22–24.	25–27.	28–30.	31–33.	34–36.	37–39.	40–42.	43–45.	46–48.	49–51.	52–54.	55–57.	58–60.	61–63.	64–66.	67–69.	
Roman Catholic	1	6	10	23	19	20	18	19	18	10	5	5	4	4	2	1	—	1	166
Protestant . .	—	7	5	18	20	15	25	13	16	12	11	9	8	—	1	1	—	1	162
Totals . .	1	13	15	41	39	35	43	32	34	22	16	14	12	4	3	2	—	2	328

TABLE F. Religion and Formal Education.

Religion.	Formal Education.								Totals.
	Good.	Fair.	Elementary.	Imperfect.	Poor.	Defective.	Bad.	Nil.	
Roman Catholic . .	6	5	118	9	1	5	4	18	166
Protestant	10	4	127	9	1	5	—	6	162
Totals . . .	16	9	245	18	2	10	4	24	328

TABLE G. Formal Education and Mental Capacity.

Mental Capacity.	Formal Education.								Totals.
	Good.	Fair.	Elementary.	Imperfect.	Poor.	Defective.	Bad.	Nil.	
Normal	10	3	70	4	—	—	2	3	92
Slightly Defective .	1	—	15	1	2	—	—	1	20
Defective	1	1	59	2	1	6	1	7	78
Very Defective . .	—	—	10	4	—	2	—	—	16
Insane	—	—	1	—	—	—	—	—	1
Totals	12	4	155	11	3	8	3	11	207

FOURFOLD TABLES.

F bis. Religion and Formal Education.

Religion.	Formal Education.		Totals.
	Better.	Worse.	
Roman Catholic .	129	37	166
Protestant . . .	141	21	162
Totals . .	270	58	328

G bis. Mental Capacity and Formal Education.

Mental Capacity.	Formal Education.		Totals.
	Better.	Worse.	
Normal	83	9	92
Defective . . .	88	27	115
Totals . .	171	36	207

TABLES F′ AND G′. EFFECTIVE EDUCATION, RELIGION, AND MENTAL CONDITION.

Effective Education.	Religion.		Mental Condition.					Totals.
	Roman Catholic.	Protestant.	Normal.	Slightly Defective.	Defective.	Very Defective.	Insane.	
Superior Education	7	2	8	—	1	—	—	9
Can read and write well . .	13	33	35	4	6	—	1	46
Can read and write imperfectly	52	58	36	11	55	8	—	110
Can neither read nor write .	27	15	13	5	16	8	—	42
Totals	99	108	92	20	78	16	1	207

FOURFOLD TABLES.

F′ bis. RELIGION AND EFFECTIVE EDUCATION.

Effective Education.	Religion.		Totals.
	Roman Catholic.	Protestant.	
Better . .	20	35	55
Worse . .	79	73	152
Totals .	99	108	207

G′ bis. MENTAL CONDITION AND EFFECTIVE EDUCATION.

Effective Education.	Mental Condition.		Totals.
	Average.	Defective.	
Better . .	43	12	55
Worse . .	49	103	152
Totals .	92	115	207

TABLES H AND I. AGE, OCCUPATION, AND CIVIL STATUS.

Civil Status.	Occupation.	Age.																		Totals.
		16–18.	19–21.	22–24.	25–27.	28–30.	31–33.	34–36.	37–39.	40–42.	43–45.	46–48.	49–51.	52–54.	55–57.	58–60.	61–63.	64–66.	67–69.	
Single	Employed .	1	8	7	15	10	8	12	6	9	2	2	1	—	—	1	—	—	—	82
	Housewives	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	—	5	7	11	11	5	10	4	5	2	—	1	—	—	—	1	—	—	62
	Independent	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Married	Employed .	—	—	—	7	12	11	11	11	8	5	3	8	5	2	—	—	—	1	84
	Housewives	—	—	—	5	2	2	3	6	7	4	4	1	3	1	1	—	—	—	39
	Prostitutes .	—	—	1	3	4	4	4	1	4	2	1	1	—	—	—	—	—	—	25
	Independent	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Widowed	Employed .	—	—	—	—	—	2	3	2	—	5	5	2	3	1	1	—	—	1	25
	Housewives	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	—	—	—	—	—	2	—	2	1	2	1	—	1	—	—	1	—	—	10
	Independent	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals		1	13	15	41	39	35	43	32	34	22	16	14	12	4	3	2	—	2	328

TABLES J AND K. INTENSITY OF ALCOHOLISM, OCCUPATION, AND CIVIL STATUS.

Civil Status.	Occupation.	Number of Convictions.																																	Totals.
		1–5.	6–10.	11–15.	16–20.	21–25.	26–30.	31–35.	36–40.	41–45.	46–50.	51–55.	56–60.	61–65.	66–70.	71–75.	76–80.	81–85.	86–90.	91–95.	96–100.	101–105.	106–110.	111–115.	116–120.	121–125.	126–130.	131–135.	136–140.	141–145.	146–150.	151–155.	156–160.	161–165.	
Single	Employed .	7	23	7	8	5	4	4	1	3	3	7	—	1	2	2	—	1	1	—	—	—	1	—	—	1	—	—	—	—	1	—	—	—	82
	Housewives	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	2	8	9	7	6	4	5	3	3	1	2	1	3	1	—	1	—	—	—	—	1	1	—	1	—	1	1	—	—	—	—	1	—	62
	Independent	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Married	Employed .	9	16	14	12	8	5	3	3	4	—	1	1	3	1	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	84
	Housewives	7	8	8	2	4	4	1	—	2	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	39
	Prostitutes .	—	4	6	6	1	4	1	—	1	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
	Independent	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Widowed	Employed .	2	4	2	2	3	1	1	—	2	2	1	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	25
	Housewives	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	2	1	—	2	—	1	1	—	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
	Independent	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals		29	65	46	39	27	23	16	7	17	7	12	4	7	6	4	2	2	2	—	—	1	2	—	1	1	2	1	—	—	3	—	1	1	328

TABLE L. Intensity of Alcoholism and Mental Condition.
TABLE M. Intensity of Alcoholism and Physical Condition.
TABLE N. Intensity of Alcoholism and Conduct in Reformatory.

No. of Convictions.	L. Mental Condition.					M. Physical Condition.		N. Conduct in Reformatory.				Totals.
	Normal.	Slightly defective.	Defective.	Very Defective.	Insane.	Fit for Hard Work.	Unfit for Hard Work.	Well-behaved.	Manageable.	Troublesome.	Very Troublesome.	
1–5	6	1	6	1	—	11	3	11	3	—	—	14
6–10	17	3	11	3	—	26	8	25	7	—	2	34
11–15	16	3	6	1	—	25	1	21	3	2	—	26
16–20	15	5	14	1	—	27	8	23	8	2	2	35
21–25	6	2	8	2	—	13	5	13	2	2	1	18
26–30	8	3	5	—	1	13	4	13	3	1	—	17
31–35	8	—	3	3	—	11	3	7	5	—	2	14
36–40	3	—	—	—	—	3	—	2	1	—	—	3
41–45	6	—	4	—	—	9	1	9	1	—	—	10
46–50	1	—	3	—	—	2	2	4	—	—	—	4
51–55	4	2	2	—	—	6	2	7	—	—	1	8
56–60	—	—	3	—	—	2	1	3	—	—	—	3
61–65	—	1	4	—	—	2	3	4	1	—	—	5
66–70	1	—	2	—	—	3	—	1	1	1	—	3
71–75	1	—	1	—	—	2	—	—	2	—	—	2
76–80	—	—	—	1	—	1	—	—	—	—	1	1
81–85	—	—	—	1	—	1	—	—	—	—	1	1
86–90	—	—	1	1	—	1	1	1	—	—	1	2
91–95	—	—	—	—	—	—	—	—	—	—	—	—
96–100	—	—	—	—	—	—	—	—	—	—	—	—
101–105	—	—	1	—	—	1	—	1	—	—	—	1
106–110	—	—	—	1	—	—	1	1	—	—	—	1
111–115	—	—	—	—	—	—	—	—	—	—	—	—
116–120	—	—	1	—	—	1	—	—	1	—	—	1
121–125	—	—	—	—	—	—	—	—	—	—	—	—
126–130	—	—	—	1	—	1	—	—	1	—	—	1
131–135	—	—	1	—	—	1	—	—	1	—	—	1
136–140	—	—	—	—	—	—	—	—	—	—	—	—
141–145	—	—	—	—	—	—	—	—	—	—	—	—
146–150	—	—	1	—	—	—	1	1	—	—	—	1
151–155	—	—	—	—	—	—	—	—	—	—	—	—
156–160	—	—	1	—	—	—	1	—	1	—	—	1
161–165	—	—	—	—	—	—	—	—	—	—	—	—
Totals .	92	20	78	16	1	162	45	147	41	8	11	207

TABLE O. Mental Condition and Physical Condition.

Physical Condition.	Mental Condition,					Totals.
	Normal.	Slightly Defective.	Defective.	Very Defective.	Insane.	
Fit for Hard Work . .	85	14	53	10	—	162
Unfit for Hard Work . .	7	6	25	6	1	45
Totals	92	20	78	16	1	207

TABLE P. CONDUCT IN REFORMATORY AND MENTAL CONDITION.
TABLE Q. CONDUCT IN REFORMATORY AND PHYSICAL CONDITION.

Conduct.	P. Mental Condition.					Totals.	Q. Physical Condition.	
	Normal.	Slightly Defective.	Defective.	Very Defective.	Insane.		Fit for Hard Work.	Unfit for Hard Work.
Well-behaved . .	79	18	40	9	1	147	110	37
Manageable . . .	12	2	25	2	—	41	37	4
Troublesome . .	1	—	7	—	—	8	7	1
Very Troublesome	—	—	6	5	—	11	8	3
Totals . . .	92	20	78	16	1	207	162	45

FOURFOLD TABLES.

O bis. MENTAL AND PHYSICAL CONDITIONS.

Physical Condition.	Mental Condition.		Totals.
	Normal.	Defective.	
Fit . .	85	77	162
Unfit . .	7	38	45
Totals .	92	115	207

P bis. CONDUCT AND MENTAL CONDITION. Q bis. CONDUCT AND PHYSICAL CONDITION.

Conduct.	Mental Condition.		Physical Condition.		Totals.
	Normal.	Defective.	Fit.	Unfit.	
Well-behaved . .	79	68	110	37	147
Not Well-behaved	13	47	52	8	60
Totals . . .	92	115	162	45	207

TABLE R. AGE AND MENTAL CONDITION.
TABLE S. AGE AND PHYSICAL CONDITION.
TABLE T. AGE AND CONDUCT IN REFORMATORY.

Age.	R. Mental Condition.					S. Physical Condition.		T. Conduct in Reformatory.				Totals.
	Normal.	Slightly Defective.	Defective.	Very Defective.	Insane.	Fit for Hard Work.	Unfit for Hard Work.	Well-behaved.	Manageable.	Troublesome.	Very Troublesome.	
16–18	—	1	—	—	—	1	—	1	—	—	—	1
19–21	5	1	2	—	—	7	1	5	3	—	—	8
22–24	4	1	6	—	—	9	2	7	2	1	1	11
25–27	14	2	7	3	—	24	2	15	7	2	2	26
28–30	13	1	10	2	—	22	4	16	7	—	3	26
31–33	9	2	10	—	1	17	5	16	4	1	1	22
34–36	12	6	12	1	—	25	6	20	7	3	1	31
37–39	11	2	6	2	—	21	—	17	2	1	1	21
40–42	8	2	11	—	—	14	7	14	6	—	1	21
43–45	5	—	3	2	—	7	3	8	1	—	1	10
46–48	2	—	6	1	—	5	4	8	1	—	—	9
49–51	2	2	2	1	—	5	2	7	—	—	—	7
52–54	4	—	2	2	—	4	4	8	—	—	—	8
55–57	—	—	—	1	—	—	1	1	—	—	—	1
58–60	1	—	—	1	—	—	2	2	—	—	—	2
61–63	1	—	1	—	—	1	1	1	1	—	—	2
64–66	—	—	—	—	—	—	—	—	—	—	—	—
67–69	1	—	—	—	—	—	1	1	—	—	—	1
Totals .	92	20	78	16	1	162	45	147	41	8	11	207

TABLES U, V, W, AND X. EFFECTIVE EDUCATION AND PHYSICAL CONDITION, CONDUCT, PROSTITUTION AND FORMAL EDUCATION.

Effective Education.	U Physical Condition.		V Conduct.				W Prostitution.		X Formal Education.								Totals.
	Fit.	Unfit.	Well-behaved.	Manage-able.	Trouble-some.	Very Trouble-some.	Prosti-tutes.	Non-Prosti-tutes.	Good.	Fair.	Element-ary.	Imper-fect.	Poor.	De-fective.	Bad.	Nil.	
Superior Education	8	1	8	1	—	—	3	6	6	—	3	—	—	—	—	—	9
Can read and write well . .	43	3	39	5	2	—	21	25	5	2	35	2	1	1	—	—	46
Can read and write imperfectly	82	28	66	30	5	9	51	59	1	1	90	7	1	5	—	5	110
Can neither read nor write .	29	13	34	5	1	2	8	34	—	1	27	3	—	2	3	6	42
Totals	162	45	147	41	8	11	83	124	12	4	155	12	2	8	3	11	207

FOURFOLD TABLES. U bis, V bis, W bis, X bis.

EFFECTIVE EDUCATION AND PHYSICAL CONDITION, CONDUCT, PROSTITUTION, AND FORMAL EDUCATION.

Effective Education.	U bis Physical Condition.		V bis Conduct.		W bis Prostitution.		X bis Formal Education.		Totals.
	Fit.	Unfit.	Well-behaved.	Trouble-some.	Prostitutes.	Non-Prostitutes.	Better.	Worse.	
Better Education .	51	4	47	8	24	31	51	4	55
Worse Education .	111	41	100	52	59	93	120	32	152
Totals . . .	162	45	147	60	83	124	171	36	207

TABLES Y, Z, AND ZZ. CIVIL STATUS AND OCCUPATION AND MENTAL CONDITION, PHYSICAL CONDITION, AND CONDUCT.

Civil Status.	Occupation.	Y Mental Condition. Normal.	Slightly Defective.	Defective.	Very Defective.	Insane.	Z Physical Condition. Fit for Work.	Unfit for Work.	ZZ Conduct. Well-behaved.	Manageable.	Troublesome.	Very Troublesome.	Totals.
Single	Employed . .	17	8	14	6	—	37	8	29	10	3	3	45
	Housewives .	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	23	—	24	5	—	43	9	27	16	2	7	52
	Independent .	1	—	—	—	—	1	—	1	—	—	—	1
Married	Employed . .	21	6	11	3	—	32	9	34	5	1	1	41
	Housewives .	12	3	9	—	—	19	5	19	5	—	—	24
	Prostitutes .	6	1	13	1	1	15	7	17	3	2	—	22
	Independent .	—	—	—	—	—	—	—	—	—	—	—	—
Widowed	Employed . .	5	2	5	1	—	7	6	12	1	—	—	13
	Housewives .	—	—	—	—	—	—	—	—	—	—	—	—
	Prostitutes .	7	—	2	—	—	8	1	8	1	—	—	9
	Independent .	—	—	—	—	—	—	—	—	—	—	—	—
Totals		92	20	78	16	1	162	45	147	41	8	11	207

UNIVERSITY OF LONDON

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BY

DAVID HERON, D.Sc.

GALTON RESEARCH FELLOW

LONDON:

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A Second Study of Extreme Alcoholism in Adults.

I. *Introductory: The History of Legislation concerning Inebriates**.

"During the years 1865 to 1870, public opinion became impressed by the need for special legislation for the proper control and treatment of inebriates, on the grounds that such persons contributed to crime and lunacy, and caused nuisance, scandal, and annoyance to the public. At that time there was no process whereby an inebriate, who became a public offender, could be dealt with, except by short sentences of imprisonment; and no means whatever by which a private inebriate could be dealt with, however much he constituted himself a cause of nuisance or distress to his family. The futility of short sentences of imprisonment, for the reform of the inebriate offender, was fully recognised by prison authorities, by those who took an active interest in prison recidivists, and by magistrates, before whom the same drunkards repeatedly came, in no way improved by the only methods then applicable; and was accentuated by certain notorious cases of persons who served, without improvement, hundreds of short sentences†."

This opinion led to the appointment in 1872 of a Select Committee which recommended that provision should be made for three classes of inebriates; (*a*) those who could pay the whole cost of their maintenance and entered Retreats voluntarily, (*b*) non-criminal inebriates committed on the petition of relatives or friends, and (*c*) persons convicted of habitual drunkenness and committed by magistrates. The Inebriates Act of 1879, however, dealt with the first of these classes only, and merely *permitted* the establishment of Retreats into which inebriates could not be admitted unless they themselves desired control.

Continued agitation resulted in the appointment of the 1892 Committee which again recommended that facilities should be provided for the compulsory committal of non-criminal inebriates on the petition of relatives or friends and for the compulsory committal of criminal inebriates. The Inebriates Act of 1898, although it did not adopt all these recommendations, was based on the Report of the 1892 Committee. It provided for the compulsory detention in Reformatories of two classes of inebriates. To be committed under Section I of the Act, an individual must be convicted of an offence punishable with imprisonment or penal servitude; it must be shown that the offence was committed under the influence of drink or that drink was a contributing cause of the offence; and finally it must be proved that the individual was a habitual drunkard. The working of this section of the Act has fallen almost entirely into the

* This section is based chiefly on the Report of the 1908 Departmental Committee (England), Chap. I. p. 7.

† *loc. cit.* p. 7.

hands of the Society for the Prevention of Cruelty to Children, and in England and Wales, up to the end of 1909, only 473 inebriates had been committed under this Section while 2836 inebriates had been committed under Section II, which requires that an individual must be convicted of one of certain offences involving drunkenness, must have been convicted at least three times within the previous twelve months of any of these offences, and again must be proved to be a habitual drunkard.

Various difficulties in the administration of these Acts led to the appointment in 1898 of a third Departmental Committee which reported, in regard to the non-criminal inebriate, that the voluntary principle was valuable and capable of further extension. The Committee recommended that inebriates should be allowed to enter into a statutory obligation to abstain from intoxicants and to make a voluntary application for the appointment of a guardian. Further it was proposed that power should be given to Judicial Authorities, on the petition of relative, friend, or guardian voluntarily appointed, to grant a compulsory order of guardianship or to commit to a Retreat. The powers of such guardians, voluntary and compulsory, were defined and improvements were suggested in the methods of licensing and managing Retreats.

In regard to criminal inebriates, the Committee recommended the removal of various restrictions which made the early committal of these inebriates difficult, such as the necessity for proving three previous convictions within twelve months, that short periods of detention should be tried before proceeding to the maximum period of three years, that every period of detention should be followed by a period of probation not exceeding one year, that more attention should be paid to the after-care of the inebriates, and that the State should give financial aid to approved After-Care Associations.

In Scotland, also, public attention has long been directed to the necessity for special legislation for the control of the inebriate, and a Departmental Committee, appointed in 1908, made recommendations which were in substantial agreement with those of the English Committee.

The recommendations of these two Committees have been embodied in a Bill, now before Parliament, for the further amendment of the Inebriates Acts but this Inebriates Bill is likely to be completely overshadowed by the introduction of a Mental Deficiency Bill by the Home Secretary, under which very wide powers are asked for dealing with various classes of the mentally defective and, among others, the mentally defective inebriate; but I shall defer consideration of these Bills until a later stage.

It is highly desirable, however, that public attention should be directed to the experience already gained in the treatment of the inebriate, as there is considerable danger that the lessons to be learnt from that experience may be overlooked.

II. *Material of present Memoir.*

Two years ago there was issued from the Galton Eugenics Laboratory a "Preliminary Study of Extreme Alcoholism in Adults*." The term "extreme

* *Eugenics Laboratory Memoirs*, No. XIV.

alcoholism" was then and is now used in a perfectly definite sense, signifying that the individual who is thus described has been repeatedly convicted of offences which were committed under the influence of alcohol. The principal objects of that memoir were "to draw attention to the need for the publication of detailed accounts of each individual inebriate" and "to induce those in whose power it lies to tabulate and publish individual records." The memoir was based on an analysis of the records of the Langho Inebriate Reformatory, published by Dr Gill in the Annual Reports of that Reformatory. These Annual Reports showed that "by a suitable choice of symbols, the account of 50 to 60 patients can be placed on a single page and 4 to 5, or, in the case of large institutions, 10 to 12 pages of printed matter would provide all the requisite data and furnish a permanent record from which all manner of investigations might start."

From the records of the Langho Inebriate Reformatory were obtained particulars regarding the age, number of convictions, religion, and education of 333 female inebriates and in addition estimates of the mental condition, physical condition and conduct in the Reformatory of 207 of this number.

The numbers on which this "Preliminary Study" was based were therefore somewhat small and the authors expressed their conclusions as follows, reminding their readers of the paucity of the data:—

(i) If the intensity of the alcoholic mania be measured by the number of convictions, there appears for constant age little relation between alcoholism and physical fitness.

(ii) There is a sensible relation between alcoholism and poor education and between alcoholism and mental defect. We consider it probable that the alcoholism is not due to the poor education nor is it to any marked extent productive of the mental defect, but the want of will-power and self-control, associated with mental defectiveness, is itself the antecedent of the poor education and of the alcoholism.

(iii) The physically stronger, judged from religion (or race) the emotionally more excitable, and, judged from intelligence, the more mentally defective, tend more to alcoholism, and give when sober in the Reformatory most trouble.

(iv) If alcoholism is the product of the association of emotionally excitable, physically stronger natures with want of mental balance, we see that it is rather the hereditary than the environmental factor to which in alcoholism, as in criminality, the first attention must be paid. It is a study of stock, not of environment, which must give us the real clue to the treatment of alcoholism.

The study of the Langho data thus raised a number of issues of the highest importance but, even if it had no other result, the discussion of these problems was more than justified by the publication in the Annual Report for 1909 of the Inspector under the Inebriates Acts* of a considerable range of particulars regarding over one thousand inebriates. The data were collected by Dr R. Welsh Branthwaite, the Inspector under the Inebriates Acts, and mark a most important advance in the study of inebriety; it is on a study of this material that the present memoir is based.

In his Report, Dr Branthwaite gives a detailed account of the 166 male and 865 female inebriates who were admitted to Inebriate Reformatories between 1st Jan. 1907 and 31st Dec. 1909. The present investigation will deal almost entirely with the female inebriates, since the numbers in the case of the men are insufficient to give

* Cd. 5799 (1911), pp. 55–93.

results on which much stress could be laid. It is very earnestly to be hoped that Dr Branthwaite will continue the collection and publication of such data in order that, when particulars of about a thousand male inebriates have been obtained, the special problems connected with inebriety in males can be investigated.

It is very important that the homogeneity of the data should be recognised. Dr Branthwaite is himself responsible for the whole of the classifications of the inebriates. In his Report (p. 17) he says:—

"These statistics, or something like them, might have been produced with less effort if they had been allowed to depend entirely upon the varied observations of a dozen individuals. In that case also a much longer list might have been compiled. But after mature consideration, it seemed better to restrict the number to 1000 or thereabouts, and enquire personally into every case so as to ensure one standard throughout. When qualities like mental condition, physical fitness or unfitness, conduct, education, or morality have to be standardised and pigeonholed according to merit, it seemed essential, above all things, that the personal equation of the observer should be a fixed quantity."

For each of these 166 male and 865 female inebriates, we are given particulars of age on admission to Reformatory, occupation, conjugal condition and, if married, whether living with husband or wife, whether, in the case of the women, the inebriates can be classed as "moral" or "immoral" where these terms are used in a special sense which will be discussed later. Details are also given regarding the number of the children of these inebriates, alive and dead, and in describing the alcoholic history of each, we are told, whether he or she drank regularly or periodically, the number of previous convictions, the duration of the alcoholism and the number of attacks of *delirium tremens*. Estimates are also given of the mental condition, physical condition, education and conduct of the inebriates while in the Reformatories and it is stated whether the inebriate is subject to fits or any organic disease. Finally, so far as information could be obtained, the relatives of the inebriates who were subject to insanity, epilepsy, habitual drunkenness and phthisis are provided.

III. *General Discussion of Characters dealt with.*

(*a*) *Sex.* Although this memoir will deal almost entirely with female inebriates, it is of some interest to notice that while 865 women were committed to Inebriate Reformatories during the three years under review, only 166 men were committed during the same period. Since the present system was initiated, 473 men have been committed to Reformatories as compared with 2836 women, practically the same proportion between the sexes. Various reasons have been assigned to account for this striking preponderance of females, such as the deficiency in institutional accommodation for men, the reluctance on the part of magistrates to commit men, and the difference between the effects of alcoholic excess upon men and women. Some interesting information on the last two points is provided in the Report on Licensing Statistics for 1910*. The main facts can best be expressed in tabular form.

* Cd. 5816, 1911.

TABLE I. *England and Wales*, 1910.

	Persons aged 15 and over	Convictions for drunkenness	Persons convicted of drunkenness	Persons committed to Inebriate Reformatories
Males.........	11,515,000	130,898	117,754	78
Females......	12,591,000	31,094	25,954	241

TABLE II. *England and Wales, except the Metropolitan Police District*, 1910.

	Persons convicted of drunkenness	Number of previous convictions for drunkenness				
		None	1—5	6—50	51—100	Over 100
Males.........	85,935	54,517	22,032	9,246	134	6
Females......	14,421	7,102	4,236	2,915	140	28

TABLE III. *England and Wales, except the Metropolitan Police District*, 1910.

	Persons convicted of drunkenness	Number of previous convictions for drunkenness				
		None	1—5	6—50	51—100	Over 100
Males.........	100,000	63,440	25,638	10,759	156	7
Females......	100,000	49,248	29,374	20,213	971	194
Ratio of Females to Males	1	·78	1·15	1·88	6·22	27·71

Table I shows that although the number of males aged 15 and upwards is slightly less than the number of females at those ages, the number of convictions registered against males is more than four times as great as the number registered against females, and similarly the number of males convicted of drunkenness is more than four times as great as the number of females convicted of drunkenness. Yet only 78 males were committed to Inebriate Reformatories compared with 241 women. These figures apply to the whole of England and Wales in 1910 but, as the records of previous convictions are not given for the Metropolitan Police District, we must leave London out in dealing with the proportions of the sexes at various stages of habitual drunkenness, and it must be said that although these records of previous convictions give a complete account of previous convictions in the police court in which the last conviction was recorded, they are by no means satisfactory so far as convictions in

other police courts are concerned. Table II shows that the number of males who had not previously been convicted of drunkenness was nearly eight times as great as the number of female first offenders. As we increase the number of previous convictions, however, the proportion of females gradually increases until, in the extreme case, among those who have more than 100 previous convictions there are 28 women and only 6 men. In Table III these numbers are given as rates per 100,000 males and per 100,000 females convicted of drunkenness. Out of these numbers 63,440 males were first offenders while only 49,248 females were first offenders. Among those who had been previously convicted, however, women are in the majority and the table shows that while 7 males per 100,000 had over 100 previous convictions, among females the proportion is 194 per 100,000, nearly 28 times as many.

This distinction between the sexes is so striking that advantage has been taken of the somewhat fuller details given in the Judicial Statistics of Scotland* to test this point further. It must be remembered however that we have in Scotland a very bad system of "forfeiting pledges" which must be taken into account. By the General Police and Improvement (Scotland) Act, 1862, Section 417, the provisions of which were re-enacted by the Summary Jurisdiction Act (Scotland), 1908, Section 14 and other Acts, it was laid down that "upon the apprehension of any person charged with any offence which may be competently tried before a court of summary criminal jurisdiction (other than the sheriff court) it shall be lawful for the chief constable... to accept bail or deposit...that such person shall appear on trial before such court." If however the accused fails to appear for trial, the magistrate may declare the pledge forfeited and although he has power to issue a warrant for the arrest of the accused, this is seldom done and the forfeiture of the pledge ends the proceedings. Unfortunately such cases are not regarded as "convictions" and a person who has been charged with drunkenness and has been "fined by consent" half-a-dozen times in this way, would be regarded as having no previous convictions and could not be dealt with under the Inebriates Acts.

This system is very extensively used. In 1909 out of 155,404 persons who were proceeded against in Scotland for all classes of offences, 22,118 were dealt with by "forfeiture of pledges." It is most often taken advantage of by persons charged with drunkenness and breach of the peace, 24 °/。 of the former and 14 °/。 of the latter being dealt with in this way.

In the Judicial Statistics, the record of previous convictions does not include such cases and hence the statistics are of considerably less value than they would otherwise be. Even in the totals details are not given for the sexes separately and the whole system is unsatisfactory from every point of view. It is very desirable that in addition to the record of previous *convictions* the record of previous "forfeiture of pledges" should be given. We are given however the previous convictions (where the word is used in this restricted sense) in greater detail than for England and the results are shown graphically in Fig. 1.

* Cd. 5417, 1910.

Here again equal numbers of males and females convicted of drunkenness have been taken. If there were *no* relationship between sex and habitual drunkenness, we should have equal numbers of males and females at every stage, that is the ratio of females to males would be unity and we should obtain a horizontal line at a constant distance of one unit above the axis. But we see that instead of being horizontal, it is for those with *no* previous convictions *below* the unit line, that is the number of female first offenders is less than the number of male first offenders. As we increase

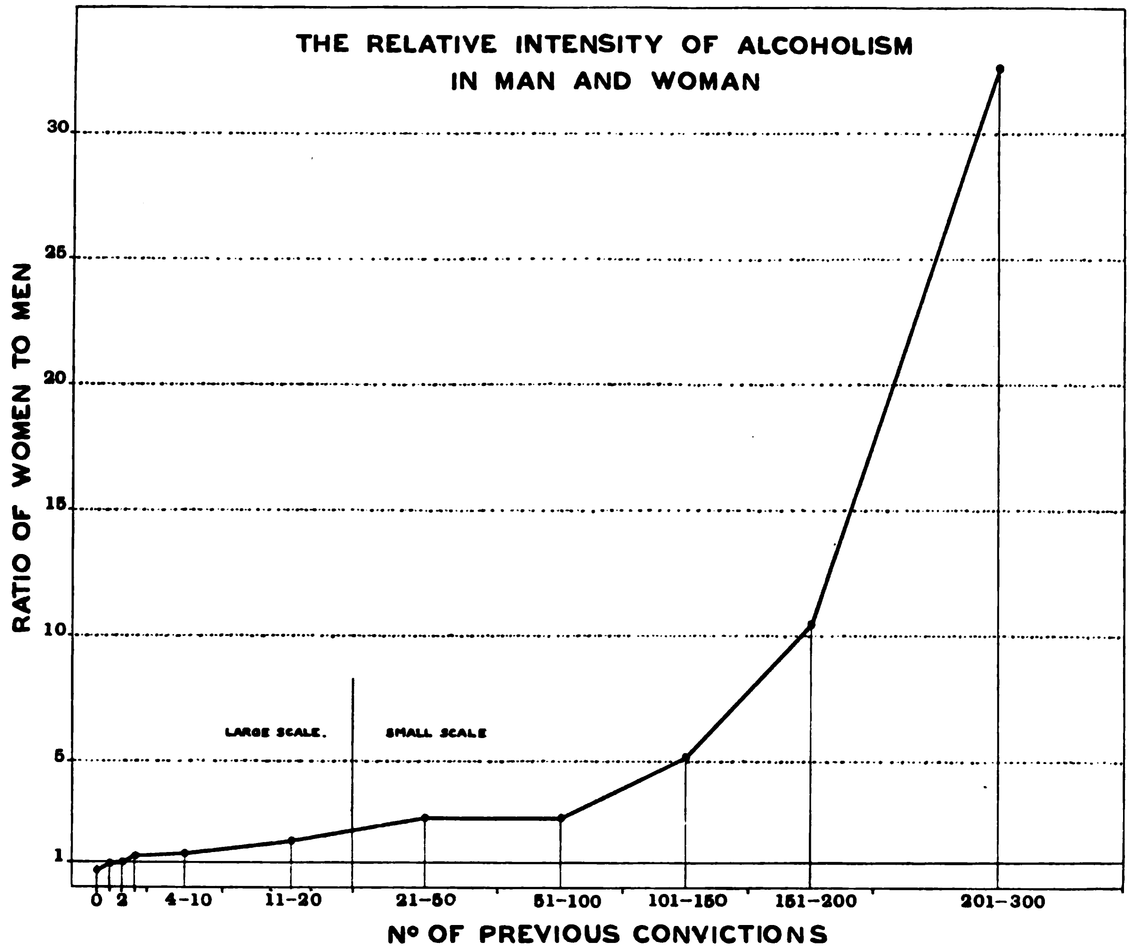

FIG. 1.

the number of previous convictions however we get an increasing preponderance of women. Among those with from 21 to 50 previous convictions there are three women to one man, while for persons with over 200 previous convictions, there are 32 women to one man. It seems to be true that here at least

> "... men, at most, differ as Heaven and Earth,
> But women, worst and best, as Heaven and Hell."

One other important distinction between the sexes may conveniently be considered here. In Table IV, I have given the conjugal condition of male and female inebriates.

TABLE IV. *Conjugal Condition of Male and Female Inebriates.*

		Married	Single	Totals	Percentage married
All Inebriates	Males.........	56	110	166	34
	Females......	707	158	865	68
Mentally defective Inebriates	Males.........	34	77	111	30
	Females......	366	188	554	66

We find that while 68 °/。 of the women are, or have been, married, only 34 °/。 of the men are, or have been, married. Among mentally defective inebriates 66 °/。 of the women are married and only 30 °/。 of the men. Men therefore are far more willing to marry mentally defective women than women are to marry mentally defective men, although some account must be taken of the greater inability of the mentally defective man to support a household. When it is remembered that nearly half of the single women are known to have given birth to children, so that of these women at least 82 °/。 have married or, if single, have given birth to children, while out of the whole 865, only 44 are moral single women—only 44 have not rendered themselves liable to maternity—it will be clear that the problems of extreme alcoholism concern female inebriates to a much larger extent than males and that we may in the first place at least confine our attention to the females.

(*b*) *Age at Onset of Alcoholism, Duration of Alcoholism, and Age on Admission to Reformatory.* These three characters may most conveniently be considered together. Of the three the statement of age on admission is the most trustworthy. The age at onset of alcoholism is obtained by subtracting the duration of alcoholism from the age on admission; and hence any error in the estimate of the duration of alcoholism is repeated in the value given to the age at onset. An examination of the frequency distribution for the duration of alcoholism shows that there is a considerable tendency to use round numbers, e.g. 5's and 10's especially when the duration is more than ten years. This might have been masked by the use of five-year groups instead of two-year groups. The statements made do not depend on the unsupported testimony of the inebriates themselves. Every effort was made to obtain confirmation of their statements from police officers, relatives, etc., and the use of the record of convictions made it certain that the duration of alcoholism given was at least a lower limit to the actual duration. "When no evidence has been available other than the statement of an inmate and when the statement has been at variance with a police record of a series of convictions for drunkenness, a date two years before the first conviction of the series has been taken as the time when habitual drunkenness presumably commenced, two years being estimated as the shortest period required to degrade an ordinary drunkard into the condition of one who is bad enough to be arrested for drunkenness and disorderly conduct."

TABLE V. *Age at Onset of Alcoholism, Duration of Alcoholism and Age on Admission to Reformatory.*

Age Groups	Age at onset	Age on admission	Age distribution of women in Shoreditch	Relative chances at each age-group*		Year Groups	Duration of Alcoholism	
				(a) of beginning to drink	(b) of being admitted to a reformatory		All cases	Before first admission
13–	25	—	857	29	—	1–	7	7
16–	210	5	895	235	6	3–	47	47
19–	151	11	902	167	12	5–	108	104
22–	62	29	865	72	34	7–	123	117
25–	69	62	753	92	82	9–	161	143
28–	75	95	675	111	141	11–	107	93
31–	73	85	608	120	140	13–	45	37
34–	53	106	554	96	191	15–	86	66
37–	43	106	522	82	203	17–	41	28
40–	30	95	497	60	191	19–	65	42
43–	31	81	468	66	173	21–	17	9
46–	24	57	432	56	132	23–	6	3
49–	14	37	375	37	99	25–	19	14
52–	2	33	322	6	102	27–	4	4
55–	1	21	264	4	80	29–	16	12
58–	2	13	243	8	53	31–	2	2
61–	—	9	221	—	41	33–	1	—
64–	—	12	182	—	66	35–	4	4
67–	—	4	150	—	27	37–	—	—
70–	—	2	122	—	16	39–	5	3
73–	—	2	93	—	22	49–	1	1
Totals	865	865	10,000	—	—	Totals	865	736

The actual distributions are given in Table V. The average age at onset of alcoholism is 27·0 years, the average duration of alcoholism is 12·1 years and the average age on admission to Reformatories is 39·1 years. It will be noticed that the first and third of these averages differ by half a year from the averages given in the Government Report. This arises from the fact that the ages given are those at last birthday and hence the inebriates will, on the average, be six months older than the ages actually given, a point which has been overlooked.

* These two columns refer to the commencement of alcoholism and to the attainment of the stage of extreme alcoholism, in the sense of committal.

In dealing with age at onset of alcoholism and age on admission to Reformatory we must, however, remember that the numbers of women in the general population steadily decrease with advancing age. Thus at age 46 there are only half as many women as at age 15 and at age 73 only a quarter as many. The number of women who begin to drink or are admitted to Reformatories at each age group per 1000 of the total female population at each age group would allow for this, but as the inebriates are certainly drawn in very different proportions from different sections of the community, it has been thought better to use the age distribution of a working class district like Shoreditch as giving a better approximation to the age distribution of the class from which the inebriates are drawn. The age distribution, within the limits of age of the inebriates, of 1000 women in Shoreditch is given in Table V. Now the assumption we are making is that the age distribution of the Shoreditch women is the same as that of the population from which the inebriates are drawn. We do not know the total of this population but if we assume it to be $N \times 10{,}000$, then the number of women between 13 and 15 will be $N \times 857$ and the age at onset of alcoholism rate for this age group will be $\frac{25}{N \times 857} \times 1000$ per 1000.

The quantity N cannot be accurately determined but the factor $\frac{25}{857} \times 1000$ will give the *relative* chance of beginning to drink at this age group. This has been calculated for every age group, for the age at onset of alcoholism and for the age on admission and the results are given in the 5th and 6th columns of Table V. The effect of allowing for age in this way is to accentuate the numbers at the later ages.

A study of the averages alone however gives a very inadequate impression of the facts. If we look at the actual distributions, we find that the age group at which the largest number of women begin to drink is from 16 to 19 years. The average age at onset of alcoholism is 27 years but 25 °/₀ of the inebriates begin to drink at the age of 18 or under, 50 °/₀ under the age of 24 and 75 °/₀ under 34. We see then that a large proportion of the inebriates begin to drink at the earliest age at which they can get access to alcohol. The distribution of age on admission to Reformatories on the other hand rises slowly and falls slowly and is more nearly symmetrical. The distinction between the two distributions is perhaps more clearly seen when the distributions are expressed graphically as in Fig. 2.

Among the 865 inebriates who are considered here, 129 are undergoing a second period of Reformatory detention, so that in 736 cases the duration of alcoholism given is that before first committal to Reformatory. Particulars of the interval between onset of alcohol and first committal to Reformatory in these 736 cases is given in Table V. The average is only slightly less than among the whole body of inebriates, 11·8 years, and we see that out of 736 cases, 319 only come under Reformatory treatment for the first time after more than 10 years of alcoholism, while in 75 cases more than 20 years of alcoholism precedes Reformatory treatment. This distribution is given graphically in Fig. 3. Whatever view be taken of the purposes to be served by the Inebriate Reformatories, it is clearly desirable that the inebriates should be dealt with at the earliest possible stage.

It should be noted that the age at onset of alcoholism given is that at which the inebriate began to drink, not that at which the first conviction took place. Had the latter information been published in the Report, it would have been possible to form some idea of the time that elapses between the onset of alcoholism and the first conviction.

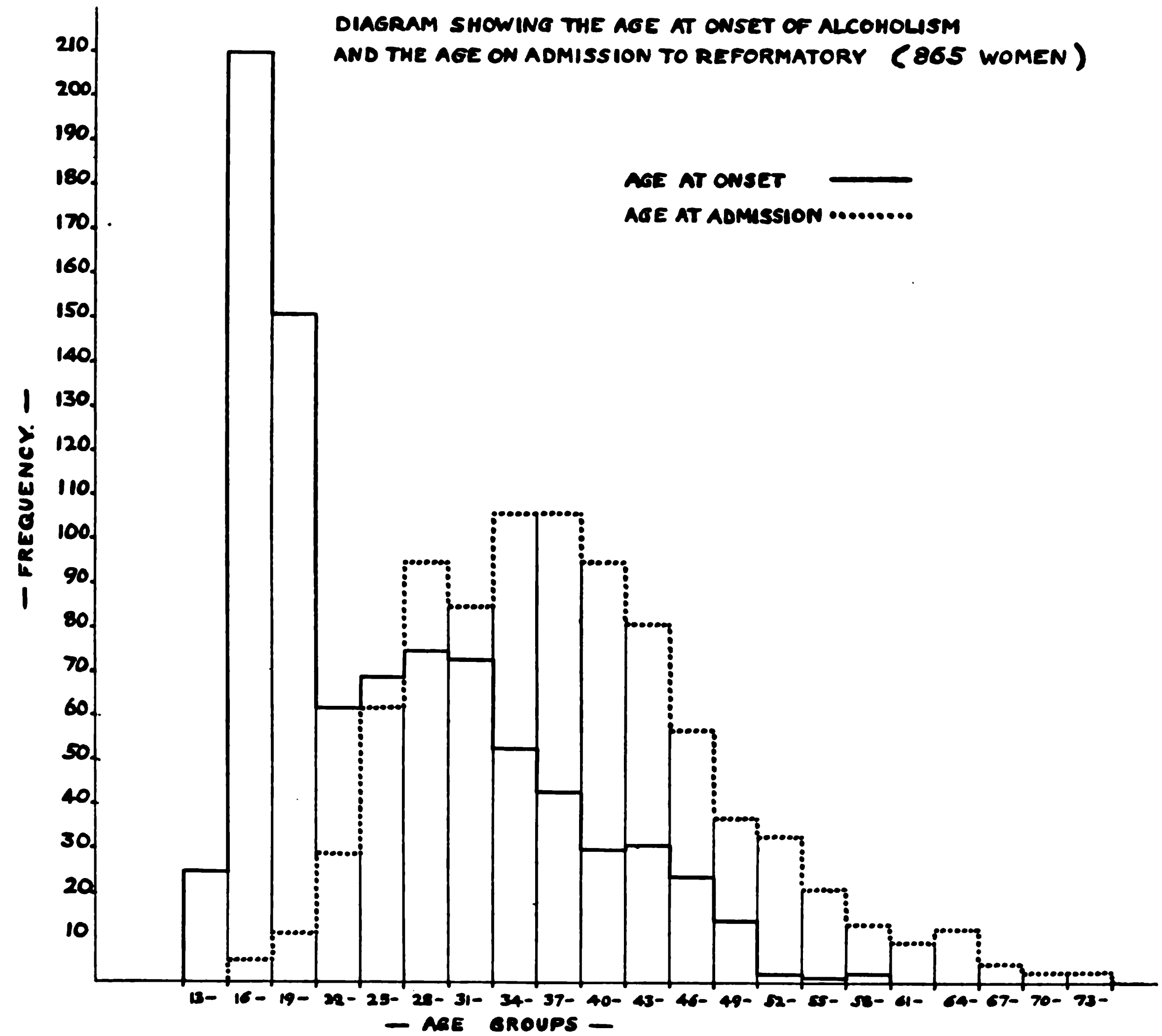

Fig. 2.

(c) *Previous Convictions.* The number of previous convictions is given for each inebriate. It must at once be admitted that the numbers given are only a lower limit to the actual number of convictions. On this point, Dr Branthwaite remarks: "Had we been able to produce a correct record of these imprisonments, the result would have been interesting and startling, but, unfortunately, this has not been possible. Inmates move about from town to town or from district to district systematically, changing their quarters as each in turn becomes too hot for them. To obtain a correct history of convictions in each case would therefore mean a careful

search of many court records, and the use of precautions for identification to counteract the confusion arising from the use of aliases. One case was closely followed some years ago with the result that the 30 or so previous convictions reported to us turned into 316; an extreme instance probably but one that illustrates the point. To have attempted such a full enquiry for over 1000 cases would have been impossible, and it has been necessary therefore to accept, unchallenged, the information supplied by the police, unless something more complete could be obtained from other sources."

In the present survey, there are some cases where the number of previous convictions is certainly understated. Thus No. 2999* is said to have had only two previous convictions. She has been drinking for 17 years, and is now in an Inebriate Reformatory for the second time, as a "Section I" case. Again No. 3143, stated to have had only 3 previous convictions and No. 2985 with only 4 previous convictions are both in Inebriate Reformatories for the second time. Both were committed under the Act which requires, for each committal, proof of three previous convictions *within twelve months*.

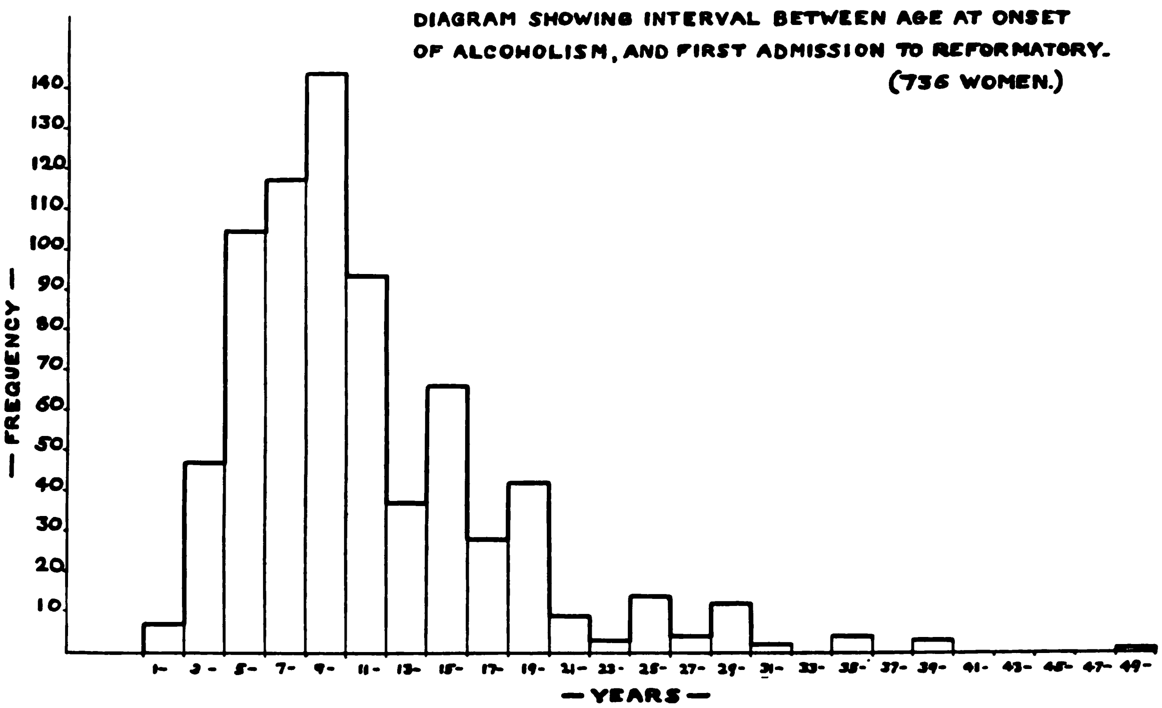

FIG. 3.

I have stated thus frankly every point that can be made against the trustworthiness of the record of convictions, but its incompleteness may easily be exaggerated. The deficiency can only arise when, as suggested by Dr Branthwaite, the inebriate moves about from town to town. Some evidence presented to the 1908 Departmental Committee on the Inebriates Acts seems to show that the inebriates remain in a single area to a much greater extent than might be supposed. In a Memorandum presented to the Committee, Mr G. Nelson, the Police Court

* The numbers are those given in Dr Branthwaite's *Report*.

Missionary at Marlborough Street, gives a return of 140 inebriates committed to Reformatories from that Police Court. Of these 74 were still in the Reformatories at the time the return was made but of the others, 44 or 69 °/₀ were again convicted at Marlborough Street after discharge. When it is remembered that some of these inebriates had only been at liberty for a very short time, and that some may have managed to keep out of the hands of the police for this limited time, it will be admitted that, in the great majority of cases, the inebriates continue to reside in the same police district and hence in those cases the full record of convictions will be obtained.

It is unfortunate that the actual time that those women spent in prison has not been given. It is obvious that a number of long sentences will substantially reduce the possible number of convictions. Especially is this the case with those inebriates who have previously undergone a period of reformatory treatment. The sentence is usually one of three years but, as details are not given, no allowance for this is possible. The offences for which the inebriates have been convicted should also be given although the available records show that over 90 °/₀ of the convictions are for offences involving drunkenness.

Making 5 convictions the unit of grouping, we get the following distribution for the number of previous convictions (Table VI).

TABLE VI. *Distribution of Numbers of previous Convictions.*

Number of convictions	0–	5–	10–	15–	20–	25–	30–	35–	40–	45–	50–	55–	60–
Frequency	89	134	129	118	79	70	54	48	32	31	21	10	7

Number of convictions	65–	70–	75–	80–	85–	90–	95–	100–	105–	110–	115–	120–	125–
Frequency	10	9	3	2	3	2	1	1	0	2	1	1	1

Number of convictions	130–	135–	140–	145–	150–	155–	160–	165–	170–	175–	Totals
Frequency	1	1	0	1	1	1	0	0	1	1	865

The average number of previous convictions is 24 while the standard deviation is 22 convictions. The highest number of previous convictions is 178 and it may be noted that the woman with this long record of drunkenness, now in an Inebriate Reformatory for the second time, is, after 22 years of drunkenness and at the age of 44, still fit for hard work in the reformatory. She only suffers from varicose veins. She is however mentally defective and can neither read nor write. Of 13 women known to have been convicted over 100 times, only 2 are unfit for hard work!

(*d*) *Number of Convictions per annum.* If we divide the total number of convictions by the duration of alcoholism, we get the average number of convictions per annum. The values given are less satisfactory than they might be for two

reasons. In the first place, as has already been pointed out, the duration of alcoholism given is that from the onset of alcoholism and not from the date of the first conviction, so that in each case we have an initial period of varying length without any convictions at all. In the second place, since the lengths of the various sentences are not given, we do not know how long the inebriates were actually in prison. One or two long sentences would materially reduce the possible number of convictions. This latter objection is however less serious in the case of the women than in that of the male inebriates.

The actual distribution is given in Table VII.

TABLE VII. *Distribution of Numbers of Convictions per annum.*

Convictions per annum	0	1	2	3	4	5	6	7	8	9	10	11	12	Totals
Frequencies	191	311	197	93	41	13	10	4	3	1	0	0	1	865

The mean number of convictions per annum is 2·06. Now although the great majority of these women have been committed under Section II of the Inebriates Act, which requires proof of three previous convictions within a year, 97 of these women have been committed under Section I for which no previous convictions require to be proved. Among Section I cases the average number of previous convictions is only 9, while among Section II cases it is 26. This accounts for a large number of the cases in which the number of convictions per annum is less than unity.

(*e*) *Mental Condition.* Of all the conditions associated with inebriety, it will generally be agreed that mental defect is by far the most important and it should be noted that here, as in all other conditions into which personal judgment enters, all the estimates have been made by Dr Branthwaite himself, so that the personal equation is at least constant. The inebriates are divided "into four groups according to mental state, (1) 'Good,' persons of average mental capacity on admission to Reformatories or after six months detention, (2) 'Defective,' persons who are of low mental capacity, eccentric, silly, dull, senile, or subject to periodical paroxysms of ungovernable temper, (3) 'Very Defective,' those who are insane but difficult to certify, imbeciles, and degenerates, and (4) 'Insane,' those who have been certified and sent to asylums during their Reformatory sentence.... Those in the first class, apart from drunkenness, are mentally capable of earning their living in rivalry with persons who are not drunkards; those in the second and subsequent classes are mentally incapable of competing on equal terms with their normal fellows."

The classification of the mental condition of these inebriates is so important that some further quotations from the Report must be given in order that a clear idea of the mental status of the inebriate may be obtained.

"Inmates of average mental capacity are just inebriates, such as are found in Retreats for voluntary patients or in private families. They are typical subjects of

constitutional peculiarity with insufficient power of self-control. Although so classed, and although not definitely defective, little difficulty will be experienced in finding traces of the three characteristics attributed to the defective. If there be no absolute defect, there are at least enough indications to warrant family resemblance. Misinterpretation concerning the meaning of occurrences, suspicion regarding the action of relatives, accusations of injustice, justification of erratic actions and denial of habitual drunkenness (despite ample evidence to the contrary) are symptoms to be found in many of them, pointing to traces of defect in intelligence and power of judgment. Disregard of truth, preference for undesirable company, carelessness as to business matters, wilful squandering of property without regard to the resulting misery to persons who should be protected, and neglect of domestic responsibilities, indicate an impaired moral sense. Imperfect control over impulse is similarly evident in the majority of these milder cases and can perhaps be recognised with greater ease than the foregoing.... Inebriates of average mental capacity earn their position in this classification of cases, not because defect is absent, but because it is less marked; so little evident, indeed, in ordinary matters as to enable them apart from drunkenness to earn their living on equal terms with other persons in their own station in life."

It is thus clear that inebriates who are said to be of "average" mental capacity are only so when kept free from alcohol. The use of the word "average" to describe a group is always unfortunate and there is little doubt that those who are placed in this group are really below the average intelligence of the community.

The "Defective" and "Very Defective" classes include "every person admitted to Reformatories who is found to be much below an average standard of mental capacity, but insufficiently so to justify a certificate of insanity. The chief characteristic symptoms observable in these cases are defective intelligence and power of judgment, perverted moral sense and imperfect control over impulse." Further Dr Branthwaite says that "nearly all those classified as very defective were insane also, but escaped certification owing to the transient character of their symptoms, or by reason of the difficulty experienced in satisfying the certifying magistrate as to the definite delusion or hallucination. Moreover no attempt has been made to certify some cases of recurrent insanity when the attacks were of short duration, otherwise the repeated transfer of inmates between asylums and reformatories would become necessary."

The number of insane inebriates is thus considerably understated and includes only those who were actually certified as insane while under sentence. On the other hand, the number of inebriates who are only slightly mentally defective or of average mental capacity is to some extent understated because some magistrates hold that the words in the Act "not being amenable to any jurisdiction in lunacy" indicate that only cases on the borderland of insanity are to be committed to Reformatories.

Out of the 865 female inebriates, 311 or 36 °/₀ are said to be of average mental capacity in the sense of the definition just given, 468 or 54 °/₀ were mentally defective, 68 or 8 °/₀ were very defective and 18 or 2 °/₀ were insane. In all, 554 or

64 °/$_0$ of these women are defective, very defective, or insane and are "mentally incapable of competing on equal terms with their normal fellows."

(*f*) *Education.* Very closely connected with the mental condition of these inebriates is the standard of education to which they have attained. The women have been divided into four groups, those with superior education, 34 in all, those able to read and write well of whom there are 268, those able to read and write only imperfectly of whom there are 451 and those who could neither read nor write numbering 112. Thus 13 °/$_0$ of these women can neither read nor write while only 35 °/$_0$ can at least read and write well. The classification of education is thus based on the mere ability to read and write. It is very difficult to get any estimate of the extent of illiteracy in the general population. Out of all the women who married in 1909 in England and Wales, only 1·3 °/$_0$ signed the marriage register with marks, the lowest percentage yet recorded, but unfortunately the ages of these women are not given so that we cannot say how widely their age distribution differs from that of the inebriates on admission to the Reformatories and therefore the comparison is of doubtful validity. A statement of the percentage of illiterates, based on the method of signing the marriage registers, in the usual decennial age groups, would be a useful addition to the Registrar-General's Annual Reports.

In the "Preliminary Study of Extreme Alcoholism," two different classifications of education were available. Under the heading, Formal Education, there was entered the kind of education that the inebriate had received, while under Effective Education, an estimate was made of the use which the inebriate had made of the education received. Although it is probable that the estimate of Formal Education was based to some extent at least on the Effective Education, the double classification was of distinct value. The relationship between the two classifications is shown in the following table, extracted from the "Preliminary Study."

TABLE VIII. *Formal and Effective Education.*

Effective Education	Formal Education			Totals
	Elementary or better	Imperfect	Nil	
Superior education	9	—	—	9
Can read and write well	42	4	—	46
Can read and write imperfectly	92	13	5	110
Can neither read nor write	28	8	6	42
Totals	171	25	11	207

It will be seen that, out of 207 women, only 11 are said to have received *no* education while 42 can neither read nor write. Again, out of 152 who are unable to

read and write well, in only 32 cases was there any want of educational facilities. It is clear then that inability to read and write comes in the main, not from any failure to receive education, but from an inability to take advantage of the education received. We have here therefore a character which is very largely determined by the mental condition of the inebriate *while of school age* and the standard of education reached by these women is thus largely a pre-alcoholic character. Until we can obtain the complete histories of these women from childhood, we can use it as such in estimating the effect of alcoholism on the mental condition of the inebriates.

(*g*) *Physical Condition.* The test of physical condition adopted is the fitness of the inebriates for hard work. They are divided into only two classes, those fit for hard work and those incapable of such work. The hard work is that which might be expected "from persons earning their living in the classes of life from which inmates of reformatories are recruited"; it comprises ordinary house-cleaning, laundry work, or kitchen work. Of the 865 women, 571 or 66 °/$_o$ are fit for hard work in the above sense, while 294 or 34 °/$_o$ are unfit for hard work. We do not, however, know what proportion of the general population of the same age distribution are fit or unfit for such work so that no comparison is possible.

(*h*) *Organic Disease.* There is of course an intimate relationship between physical condition and the presence or absence of organic disease. For the present purpose the inebriates have been divided into five groups in dealing with organic disease, and we find that 519 or 60 °/$_o$ suffer from no organic disease, 152 or 18 °/$_o$ suffer from general debility, 73 or 8 °/$_o$ suffer from heart disease, 33 or 4 °/$_o$ from syphilis and 88 or 10 °/$_o$ from "other causes" where this term includes 16 cases of bronchitis and allied diseases, 10 cases of cancer, and 6 of phthisis. Dr Branthwaite in his Report (p. 41) gives a full list of these diseases, and lays great stress on the fact that in nearly all cases the disease is in a *chronic* condition.

What part has alcohol played in producing these conditions? We have no sample of the general population with which we can compare the incidence of disease among the inebriates. There are several points however in Dr Branthwaite's Report (p. 41) which deserve emphasis. The first is that these inebriates are under the closest medical supervision. "Every inmate of a Reformatory, as a matter of routine, is subjected on admission, and periodically afterwards, to a close physical examination not applied to persons in the same class in ordinary life. It is more than probable therefore that many of the milder conditions referred to in the 'organic disease' column would have escaped notice but for the admission of the subject to detention, and his compulsory examination." Further, the medical officers are naturally anxious that no diseased condition should be overlooked and it must be remembered that to the inebriate the presence of organic disease means the possibility of escaping from the hard work of the Reformatory. All these circumstances tend to *exaggerate* the actual amount of organic disease among these inebriates and yet we find that 77 °/$_o$ of them are free from definite organic disease.

After making due allowance for this more than usually complete statement of diseased conditions, are we to conclude that these conditions are due to the direct

effects of alcohol? This question has been discussed so fully by Dr Branthwaite that it seems best to give his own words. He says (Report, p. 40):

"It is by no means clear, however, to what extent the actual drinking of alcohol is responsible for the production of the permanent tissue changes that must be inferred from these returns; in other words, it is difficult to determine which of the many diseases are actually and directly due to the excessive use of alcohol, and which of them are merely associated with it as the result of attendant influences. The evidence before us is extremely conflicting and proportionately inconclusive. On the one hand standard medical text-books attribute many organic and functional disorders to the action of alcohol taken in excess, and monographs, written by influential persons, are devoted to a verbal and pictorial description of the prejudicial action of alcohol upon the human body when taken in excess and even in moderation. On the other hand medical men of experience, who have devoted their lives to the study and treatment of alcoholism, tell a somewhat different tale. Many of these persons declare that when confirmed inebriates have been protected from injury and exposure, uniformly well fed and maintained in good hygienic state, during their drunken years, the permanent physical injury (as distinct from temporary derangement) attributable solely to persistent drunkenness is small indeed; in the large majority of cases altogether absent. They say that when such persons are made sober and kept sober for two or three weeks, they usually become healthy individuals so far as physical condition is concerned, notwithstanding that the majority have been drinking heavily for many years.... Chronic alcoholism undoubtedly retards recovery from injury, causes temporary gastric and intestinal disorders, predisposes to pneumonia during heavy drinking and makes that malady exceptionally fatal, affects brain diseases to the extent already shown, and renders its victims susceptible to many fell conditions by causing neglect of hygienic principles, and by subjecting them to more opportunity for contracting disease. There is however, in the opinion of the writer, insufficient evidence to show that excessive indulgence in alcohol *per se* produces the amount of permanent injury to health that is attributed to it, or might reasonably be expected from it."

Although we cannot obtain any estimate of the numbers of women in the community who are suffering from the various diseases noted, we know at least the number of inebriates who have died during sentence and the death-rate in the general population. Can these figures be used to compare the incidence of disease among inebriates with that among the general population? The question is one of great difficulty. In the first place we do not know the extent to which the inebriates have been selected before being committed to Reformatories. Do inebriates who are seriously ill enter the Reformatories at all? On this point the evidence is somewhat conflicting. On the one hand, in the General Regulations for the Management and Discipline of Certified Inebriate Reformatories, it is laid down (Rule 66) that "Chronic invalids, incapable of earning their own livelihood, and persons who require special care and constant medical attention, or persons suffering from any contagious or infectious disease, shall not be eligible for an Inebriate Reformatory. Persons suffering from any organic disease in an advanced stage are not fit subjects for admission, and in all cases of pulmonary tuberculosis special precautions should be taken to prevent the communication of the disease to others." On the other hand, if we study Table XIII of Dr Branthwaite's Report for 1909, which gives particulars of all deaths of inebriates while under sentence, we see that inebriates in an advanced stage of tuberculosis are to be found in the Reformatories.

Details are given of the deaths of 44 inebriates who have died while under sentence and it will be seen that in all but 12 of these cases the disease was evident on admission. Unfortunately the time that elapsed between admission to Reformatory and death is not given. We find, however, it is said of three cases of phthisis that the disease was evident on admission and too advanced for more than temporary benefit to result from treatment. Further, it should be noted that with a few exceptions all the diseased conditions among the 865 inebriates were evident on admission. It would seem then that the actual amount of selection before admission is somewhat smaller than the Regulation just quoted would suggest. The information given in the Report is insufficient to test this point adequately. It is at least obvious that before being committed to an Inebriate Reformatory, a person must be well enough to become drunk (and in most cases disorderly also) and it is natural to suppose that, apart altogether from any Regulation, persons found to be in an advanced state of disease after arrest would be sent to hospital rather than to Inebriate Reformatory. Further, the close medical supervision under which the inebriates live while under sentence must have a marked effect in reducing the death-rate among them while under sentence. Any discussion of the mortality of the inebriates while under sentence must therefore be to some extent inconclusive.

One other point must be considered. May it not be the case that all the inebriates who are at all unfit die before they reach the stage at which they would be committed to Reformatories and that the more fit survive? To test this point completely we should require the complete alcoholic histories of a number of women from the onset of alcoholism, but in the absence of such data, it may be said that an average duration of alcoholism of 12 years lends little support to such a view.

In all 2767 women have been committed to Inebriate Reformatories. How many deaths would occur among women of the same age in the general population? The actual age distribution of these 2767 women is not given in a form that can be used (i.e. not in the usual decennial groups), but we may safely assume that it does not differ widely from that of the 865 women for whom individual ages are given. We find then that of 865 inebriates, 318 are between 35 and 45 years of age. Now the death-rate among women in England and Wales during the decade 1891—1900, in this age group, is 9·59 per 1000. From 318 inebriates we may thus expect 3·0496 deaths per annum. Repeating this operation for every age group we get the following results (Table IX).

Out of 865 inebriates we thus expect 9·5911 deaths per annum or 30·6804 out of 2767. Now in the majority of cases, the sentence was one of three years committal to Reformatory. Actually the average sentence was 2·68 years. A number of women owing to death, or non-completion of sentence, were not under observation during the whole period of their sentences; on the other hand the age distribution taken is that of the inebriates on admission. The ages at the middle of the period of observation will be more than a year greater than those given and this will increase slightly the number of expected deaths. These two factors may be left to cancel each other and we shall be safe in taking $2\frac{1}{2}$ years as the average period of observation. Multiplying

the annual number of deaths by $2\frac{1}{2}$, we thus find that out of 2767 women under observation for $2\frac{1}{2}$ years we may expect 76·7 deaths, if their death-rate is the same as that of the general population. This is greatly in excess of the 39 deaths which actually occurred among the female inebriates and we see that the death-rate among inebriates while under sentence is only half that of the general female population of the same age distribution.

TABLE IX. *Deaths from all causes.*

Ages	Age Distribution of Inebriates	Death rate per 1000 in England and Wales	Expected Deaths
15–	6	3·67	·0220
20–	39	4·46	·1739
25–	281	6·08	1·7085
35–	318	9·59	3·0496
45–	158	14·74	2·3289
55–	47	28·44	1·3367
65–	16	60·72	·9715
Totals	865	—	9·5911

In making this comparison we have, however, assumed that we may fairly compare these inebriates with the total female population of England and Wales. The comparison ought to be made with women of the class from which the inebriates are chiefly drawn. At present there is no means of doing so, since mortality rates for different classes of women are not available. The Registrar General however provides such data for men in Decennial Supplements, Part II. It was thought that the class among men to which these inebriates most closely corresponded was that of general labourers, and this was confirmed when it was found that out of 166 male inebriates 61 were classed as general labourers and 23 as belonging to other indefinite occupations such as hawkers, general dealers, rag-pickers, etc., who have an equally high death-rate. Now the death-rate among general labourers is 2·235 times that of all males, the ages taken being between 25 and 65. On the assumption then that the class from which the inebriates are chiefly drawn bears the same relationship to the total female population as do general labourers to the total male population, we should expect 171 deaths from 2767 inebriates while under sentence. As we have seen the actual number is only 39.

Before discussing the weight to be attached to this result we ought perhaps to consider the mortality among the inebriates from certain diseases. Special attention is devoted in the Report to the relationship between inebriety and malignant disease and the conclusion is reached that the mortality from cancer "is more than eight times greater than that which obtains throughout the country." I find however

that in comparing the incidence of cancer among inebriates with that in the general population, the cancer death-rate in the general population taken is that of females of all ages (including infants), that no correction has been made for differences of age distribution, and that sickness rates have been assumed as equivalent to mortality rates, so that it seems desirable to go into this question more fully, discussing at the same time the death-rate among inebriates from phthisis.

The facts are that out of 865 inebriates 10 suffered from cancer and 5 died during sentence, 6 women suffered from phthisis of whom 1 died during sentence and there were 8 deaths from all causes. Out of 2767 inebriates, the total number committed to Reformatories, 24 suffered from cancer of whom 10 died from cancer, 6* died from phthisis and there were 39 deaths from all causes. These figures must be compared with the sickness and mortality rates from cancer and phthisis among non-inebriate women of the same age distribution and of the same social class. The inebriates form so small a proportion of the whole that the rates among the non-inebriate will differ very little from those of the whole population. Sickness rates are not available and we must thus confine our attention to mortality rates. The first step is to find what number of deaths from cancer and phthisis are to be expected in a sample of the general population of the same size and age distribution as those of the inebriates. The method is the same as that already used in dealing with deaths from all causes and the results are as follows:—

TABLE X. *Deaths from Cancer and Phthisis.*

Ages	Age Distribution of Inebriates	Cancer		Phthisis	
		Death rates per 1000	Expected deaths	Death rates per 1000	Expected deaths
15–	6	·027	·0002	1·290	·0077
20–	39	·039	·0015	1·591	·0620
25–	281	·175	·0492	1·923	·5404
35–	318	·891	·2833	2·121	·6745
45–	158	2·323	·3670	1·642	·2594
55–	47	4·099	·1927	1·239	·0582
65–	16	5·829	·0933	·807	·0129
Totals	865	—	·9872	—	1·6151

We thus find that out of 865 women we should expect ·9872 deaths per annum from cancer and 1·6151 deaths from phthisis, if their death-rates were the same as those of the total population of England and Wales at the same age groups. Hence

* This includes one death from "Phthisis and heart disease, both conditions of long standing and progressive."

from 2767 women under observation for $2\frac{1}{2}$ years the expected deaths number 7·9 from cancer and 12·9 from phthisis. If as before we assume that the class from which the inebriates are drawn bears the same relationship to the total female population as general labourers do to the total male population, we get finally that the expected deaths from cancer number 14·9 and those from phthisis number 34·1. Actually there were 10 deaths from cancer and 6 from phthisis.

What weight must be given to these results? As they stand, they show that the death-rate from all causes among inebriates while under sentence is only half that of the total female population of England and Wales and is less than a fourth of the death-rate of the class from which they are drawn, if the assumptions made in arriving at the death-rate among this class be accepted; the death-rate among inebriates from cancer is slightly less and from phthisis is decidedly less than in this class. The lower death-rate from phthisis is possibly due, to some extent at least, to selection before admission and close medical supervision after admission to the Reformatories. On the other hand it must be remembered that the Imperial German Bureau of Statistics* recently came to the conclusion that the alcoholic as a class suffer less from tuberculosis than the non-alcoholic. Professor Karl Pearson has recently called attention to this result† and his words may be quoted here:—

"The data are provided by the Leipzig *Krankenkasse* and the alcoholic are those upon whose sickness cards the doctor had written 'P' (= potator), 'Chronische Trunksucht,' 'Delirium Tremens' or 'Säuferwahnsinn'; the distinction is thus between immoderate drinkers and the remainder. For 1000 observed persons tuberculosis of all kinds occurred in the following proportions for three age groups:

TABLE XI.

Tuberculosis	Ages					
	15—34		35—54		55—74	
	Alcoholic	Non-Alcoholic	Alcoholic	Non-Alcoholic	Alcoholic	Non-Alcoholic
Cases of sickness ...	4·2	6·7	7·4	10·2	9·4	10·0
Days of sickness ...	259	529	408	858	644	824
Deaths	1·39	1·90	1·34	3·32	4·72	3·92

The official report recognises that with tuberculosis the sickness and mortality results are more favourable to the alcoholists than to the total population. The explanation given is of course not that alcohol protects the consumer from the tubercle bacillus, but that the men of better

* *Krankheits u. Sterblichkeitsverhältnisse in der Ortskrankenkasse für Leipzig u. Umgegend. Untersuchen über den Einfluss von Geschlecht, Alter u. Beruf.* Bearbeitet im kaiserlicher Statistischen Amte, Bd. I. Teil c. S. 190—8.

† 'The Fight against Tuberculosis and the Death-rate from Phthisis.' *Questions of the Day and of the Fray,* No. IV. p. 16 (Dulau and Co.).

physique are those who take more readily to alcohol. An analysis of the trades followed shows this to be the case, precisely as Miss Elderton and I found for the Edinburgh data*."

A study of the mortality of women who are at the beginning of their alcoholic careers, from, say, the date of first conviction, would be of the utmost value but the necessary data are not available. Some light may be thrown on this point by a study of the mortality of the inebriates after discharge. In only one series of observations are we given the ages of the inebriates and the time they were under observation. Dr Gill in his Report for 1910 on the Langho Inebriate Reformatory gives particulars of the after-histories of 227 inebriates. Of these 13 died and 10 were not traced, so that we have 13 deaths out of 217 inebriates. Now the average age of these inebriates on admission to the Reformatory was 36·7 years, the average sentence 2·9 years and the average period of observation after discharge was 2·5 years. Thus at the middle of the period of observation after discharge the average age of the inebriates was 42·1 years. Now the death-rate among all women in England and Wales for the decade 1891—1900 in the age group 35—45 was 9·59 per 1000 per annum, while at the age group 45—55 it was 14·74. At 42·1 years it may be taken as 10·3 per 1000 per annum. Hence out of 217 women under observation for $2\frac{1}{2}$ years we expect $10{\cdot}3 \times 217 \times 2{\cdot}5 \div 1000 = 5{\cdot}59$ deaths per annum on the basis of the general death-rate in England and Wales at the same age groups. But if as before we assume that the class from which the inebriates are chiefly drawn differ from the total female population of England and Wales to the same extent as do general labourers from all men, we must multiply this number, 5·59, by a factor 2·235 reaching as our expected number of deaths, 12·5. The actual number of deaths was 13.

Now the selection of the inebriates took place before admission to the Reformatory and the actual period of observation was from $2\frac{1}{2}$ to 7 years after admission, so that the effects of selection after an average of 5 years would be very small. In such circumstances we see that the death-rate among inebriates is only slightly greater than the death-rate of the class from which they may reasonably be expected to be drawn, and this difference itself is not significant.

The proportion of deaths from cancer to deaths from all causes is decidedly high; experience seems to suggest that women suffering from cancer often take alcohol in order to mitigate pain and this may account for some at least of the excess.

Dr Branthwaite raises a very interesting point in discussing the relationship between prostitution and cancer of the mammary and generative organs. After correcting for differences of age distribution, we find that 71 °/ₒ of the cancer among inebriates affects those organs while in the general population the proportion is 53 °/ₒ. Among inebriates who are prostitutes the percentage rises to 87·5 °/ₒ compared with 52 °/ₒ in the general population. The numbers are small however and do not justify

* Elderton and Pearson: 'A First Study of the Influence of Parental Alcoholism.' (Dulau and Co.) In the *Medical Temperance Review*, May, 1912, p. 75, Professor Sims Woodhead speaks of these results as if they referred to tuberculosis among brewers' employees. They refer of course to *all* occupations; and therefore Professor Woodhead has apparently not read the paper he deals with.

further analysis, but the point is an important one and ought to be tested on wider data.

None of those prostitutes who had cancer are marked as having had syphilis also, but it is not quite clear from the Report whether other and less severe forms of disease have been recorded in addition to the principal disease; certainly no case of an inebriate having two diseases at the same time is noted among the 865 female inebriates dealt with in this memoir. Only 33 women are said to have had syphilis, a surprisingly small number when it is remembered that 447 women out of the 865 are known to have led immoral lives before committal to Reformatories. Many more however are said to have suffered from syphilis at some time during their lives. "Many of the women bear the stamp of congenital syphilis, wizened and wasted appearance, stunted growth, prominent forehead, asymmetrical skull, deformed teeth, etc., which, if there is anything in immunity, may account to some extent for their freedom from infection." It should also be noted that cases of primary syphilis are not admitted to Reformatories.

Considerable attention has lately been paid to the relationship between cancer and syphilis. Thus Professor Rutherford Morison recently stated* that "Cancer and syphilis are very firm allies and syphilis often provides a suitable site for the lodgement of cancer. If a person over 60 years of age contracts syphilis, his death from cancer may be anticipated." Dr F. von Esmarch is more definite. After giving particulars of various cases, he says† that "unter der in den letzten Jahren in meiner Klinik beobachteten Sarcoma mehr als die Hälfte zu den Syphilnomen zu rechnen waren und durch ante-luëtische Behandlung geheilt werden konnten." The question is one of great interest and it is to be hoped that further data may be collected in order that the point may be settled.

It is hardly necessary to discuss in detail the other diseases on the list but it should be noted that not a single case of cirrhosis of the liver occurs among these 865 female inebriates. Since Reformatories were opened there have only been two very doubtful cases of cirrhosis of the liver out of over 3300 inebriates. The Medical Officer of the Reformatory in which they occurred says, "I think these cases are suffering from cirrhosis of the liver, but of course it may not be due directly to the action of alcohol. In neither case can I get a history of excessive spirit drinking." Dr Branthwaite states that "no instance of haematemesis, other than one or two caused by gastric ulcer, has ever been treated in any such institution, and no case of hepatic dropsy has come under observation....The conspicuous absence of disease of the intestinal tract, disease of the kidneys, and gout, is worthy of mention."

(*i*) *Delirium Tremens.* Out of the 865 female inebriates 61 are known to have suffered from *delirium tremens* while six‡ cases are marked doubtful. In every one

* *British Medical Journal*, 19 Nov. 1910, p. 1573.

† 'Ueber die Aetiologie und die Diagnose der bösartigen Geschwälste, insbesondere derjenigen der Zunge und der Lippen.' *Verhandlungen der deutschen Gesellschaft für Chirurgie.* 18er Congress, II. S. 120—142. Berlin, 1889.

‡ In the *Report* p. 32 it is stated that seven cases are marked 'doubtful' but I can only trace six.

of these doubtful cases, however, "there were good reasons for supposing an attack. A history of heavy drinking followed by a sudden seizure, removal to a workhouse infirmary, detention there for a week or ten days of which the inmate knew but little, except that he had been 'off his head,' with a history of rapid recovery and discharge, is fair presumptive evidence of *delirium tremens*." In the present study, it was assumed that in such cases an attack had actually occurred. If therefore we include the doubtful cases we find that only 7·7 °/₀ of these women had suffered from *delirium tremens*. This is surprisingly small and Dr Branthwaite gives particulars of a series of 561 heavy drinkers admitted to a Retreat. The sex of these inebriates is not stated but it was found that 308 or 37 °/₀ had a history of *delirium tremens*. Apart from the difficulty in obtaining complete returns among inmates of Retreats, Dr Branthwaite considers that there is a real difference between such cases and inmates of Reformatories. "The former," he says, "can drink enormous quantities of alcohol and remain phlegmatic until incapable; the latter become excited, turbulent or dangerous, after imbibing a comparatively small quantity. The former, having adequate means, can afford to drink continuously; the latter cannot. The Retreat case often drinks steadily until he is brought up by an attack of delirium; the Reformatory inmate after drinking a comparatively small quantity renders himself liable to arrest and is saved from the same result by a few days' or weeks' sobriety in prison. On these grounds it is probable that fewer cases of *delirium tremens* will always be found among Reformatory inmates than among Retreat patients and that the figures now presented may be more approximately correct than at first appeared."

(*k*) *Epilepsy*. Out of 865 female inebriates, 43 were found to be epileptic, of whom one became insane during detention. 5 °/₀ of the inebriates, sane or insane, were thus epileptic. This is far in excess of the proportion in the general population. The medical investigators of the Royal Commission on the Feeble-Minded* found that out of a total female population of 1,215,117 in certain representative areas, there were 637 sane epileptics, a proportion of ·05 °/₀. If we add ·02 °/₀† for the proportion of insane epileptics we get a total of ·07 °/₀. The proportion of epileptics is thus more than seventy times greater than in the general population.

Now epilepsy is generally recognised to be a hereditary defect; we have already seen that feeble-mindedness, another hereditary defect, is also associated with inebriety to a very marked extent and it is thus clear that these inebriates belong to a class of degenerates whose defects will almost certainly be transmitted to their children.

(*l*) *Conduct*. It has already been explained that the State Inebriate Reformatories, although originally intended for Section I cases, are now used almost exclusively for inebriates who cannot be controlled in the Certified Inebriate Reformatories, whether they were committed under Section I or Section II. Such inebriates are only admitted to the State Reformatories after it has been found that the discipline of the Certified Reformatories is insufficient. Out of 44 inebriates

* *Report*, Vol. VI. p. 57.

† 60*th Report of the Commissioners in Lunacy*, p. 150.

received into the State Inebriate Reformatories at Aylesbury and Warwick during 1909, only 4 were received direct from a committing court; the rest were transferred from the Certified Inebriate Reformatories on the ground of refractory conduct. A classification of this kind, although quite definite, is not without serious disadvantages owing to the fact that these "uncontrollable" cases form so small a proportion of the whole; these inebriates were however further classified into four groups in dealing with conduct, the well-behaved of whom there were 597, the manageable numbering 164, the troublesome numbering 63 and the very troublesome numbering 41. The "very troublesome" thus correspond more or less closely to the "uncontrollable" class who have to be sent to the State Inebriate Reformatory. Although all these 865 inebriates were committed for disorderly conduct of one form or another, we see that 69 °/ₒ give no trouble when kept free from alcohol, while a further 19 °/ₒ are said to be "manageable," i.e., although liable to give trouble, they can be controlled if tactfully handled.

(*m*) *Civil Status.* I have already shown that female inebriates are far more often married than male inebriates. If we consider the civil status of the female inebriates in greater detail we find that out of a total of 865 women, 277 are single, 176 are married women living with their husbands, 254 are married women living apart from their husbands and 158 are widows. In order to discuss the relationship between civil status and inebriety in the general population we require to know the distribution of civil status among *all* women of the same class (apart from inebriety) and of the same age distribution. This cannot be obtained directly, but an approximate value can be obtained by considering the distribution of civil status among women of (*a*) all England and Wales and (*b*) the Metropolitan Borough of Shoreditch. I consider the distribution of civil status in Shoreditch, although not altogether satisfactory, a better approximation to the distribution of civil status of the class from which these inebriates are drawn than that of all England and Wales. The method by which these distributions are obtained is shown in Table XII. We find

TABLE XII. *Civil Status and Inebriety.*

Ages	Single			Married			Widowed			Totals
	Inebriates	England and Wales	Shoreditch	Inebriates	England and Wales	Shoreditch	Inebriates	England and Wales	Shoreditch	
15–	6	5·9	5·9	—	·1	·1	—	—	—	6
20–	33	28·3	24·7	6	10·6	14·2	—	·1	·2	39
25–	120	95·5	67·4	133	180·7	205·8	28	4·8	7·8	281
35–	79	58·9	33·3	181	238·7	255·3	58	20·3	29·4	318
45–	28	21·5	12·4	89	111·4	107·9	41	25·1	37·8	158
55–	9	5·5	4·0	16	26·8	23·4	22	14·7	19·6	47
65–	2	1·8	1·5	5	5·9	4·6	9	8·3	9·9	16
Totals	277	217·4	149·2	430	574·2	611·3	158	73·3	104·7	865

for instance that there are 281 inebriates between the ages of 25 and 35 of whom 120 are single women. Now out of 9349 women aged 25—35 in Shoreditch, 2242 are single; thus $\frac{2242}{9349} \times 281 = 67 \cdot 4$ single women might be expected out of 281. Repeating this operation for each of the seven age groups and summing the results we find that in Shoreditch, among women of the same ages as the inebriates, there would be 149 single women, 611 married women and 105 widows, while in all England and Wales, there would be 217 single women, 574 wives and 73 widows. It is thus clear that there is a very large excess of single women among these inebriates. They marry to a much less extent than the women of a working class district like Shoreditch. Our satisfaction at this state of affairs in view of the large amount of mental defect among these women must be moderated by the knowledge that these 277 single women have had 210 children and that this number is almost certainly understated.

Of the 430 married women, 254 or 59 °/₀ were living apart from their husbands. We cannot obtain any estimate of the number of women in the country who are permanently living apart from their husbands but the proportion must be very small, since in only 7 °/₀ of cases were women enumerated at the 1901 Census as being away from their husbands on the night of the Census. This 7 °/₀ includes all cases of temporary absence so that, as might indeed be expected, married inebriates are far more often separated from their husbands than in the general population.

(*n*) *Occupation.* In dealing with the occupations of these inebriates, I have divided them into three classes, (i) housewives, (ii) women who are industrially employed and (iii) women who are said to have no occupation. There are 160 women who are entered as housewives. These are married women who are performing ordinary household duties, and in all but 23 cases are living with their husbands. Of those who are industrially employed, 476 in all, 188 are classed as domestic servants, 76 as laundresses, 68 in dressmaking and allied occupations, and 54 as hawkers, flowersellers, etc. In 229 cases the women are said to have no occupation, but, in all save 29 cases, this means that these women are prostitutes, "living upon the proceeds of immorality," the exceptions being married women living with their husbands but taking no part in household duties, married women living apart from their husbands on separation allowances, or widows subsisting on means of their own. It must be remembered that the occupations given are those which were followed by the inebriates just before committal; for an adequate study of the relationship between occupation and inebriety, we require the whole alcoholic histories of these women. The most striking point that arises in dealing with the occupations of these inebriates is the fact that prostitution forms the sole means of livelihood of at least a quarter of them; it is a fact, however, that must be faced.

(*o*) *Morality.* The inebriates are divided into two classes in dealing with sexual morality. The term "immoral" has been used to describe "only those women who have been convicted of prostitution or 'soliciting' (as shown by police court records) unless very good evidence of a life of prostitution could be obtained from other sources. In our statistical tables only 24 very clear cases, without history of police prosecution,

are included as immoral; the rest are so described owing to convictions recorded against them for prostitution or offences that imply prostitution." It is thus clear that the term "moral" is used in a very special sense, and is applied only to those who are not known to be prostitutes. "No woman who has cohabited with one man, living with him as his wife but without going through any form of marriage, has been included among the immoral; nor have some single women been so included who have given birth to children during early life, but have subsequently lived decently moral lives, so far as could be ascertained." There are 14 single women classed as "moral" who have given birth to children of whom 10 have had one child and one each with 2, 3, 4, and 6 children.

Using the terms in the way thus indicated we find that 418 women are classed by Dr Branthwaite as "moral" and 447 as "immoral." It is hardly possible to obtain anything but an extremely vague appreciation of the proportion of women in the general population who would be classed as "immoral" in the sense in which the term is used here, but it will at once be admitted that it falls far short of the 52 °/。 of immoral women among these inebriates. This high proportion of immoral women and the even higher proportion of mentally defective women among the inebriates mark them as a class apart.

(*p*) *Regular or Periodic Drinking.* The inebriates are also divided into regular and periodic drinkers, there being 576 of the former and 289 of the latter. The classification is so vague and indefinite that it lends itself admirably to verbal disquisition and is therefore in high favour with writers on alcoholism. Dr Branthwaite is more than doubtful of the value of the distinction and his views are expressed in the following quotation from his Report (p. 31): "Those of us who have dealt with many hundreds, even thousands, of units belonging to both classes, are not prepared to endorse the definite distinction implied by the separate consideration and separate naming of these types. We consider that although clinical characteristics may possibly justify a division into 'regular' and 'periodic,' the fundamental condition underlying both states is the same, and separate naming only leads to confusion. Moreover, there is no line of demarcation between the two extremes, some cases being neither periodic nor regular, others sometimes periodic and sometimes regular. Both classes are inebriates in every sense of the word, and it is better to consider them as such, than attempt a distinction that cannot be maintained. Apart from the mere fact of regularity or periodicity, both classes present the same clinical features and require practically the same treatment. Amongst many specimens of both types, now indiscriminately mixed in institutions for inebriates, it is impossible by any characteristic to sort them into classes without enquiry into previous history."

IV. *The Methods of measuring Relationships between the various Characters.*

This discussion of the average age of the inebriates, of the range in number of convictions, of the percentage who are mentally defective, etc., has enabled some picture to be formed of the main characteristics of the inebriates. So far however we have discussed each of these characters separately; we must now go a step further

and discuss the relationships between the various characters; we must consider, for instance, whether those of average intelligence or those who are mentally defective are convicted more often, whether mental condition or physical condition is more closely related to the duration of alcoholism.

How are these relationships to be measured? It is obviously not sufficient to state that there is a *close* relationship between one pair of characters and *some* relationship between another pair. We must find a *quantitative* measure of these relationships, we must express them in numbers. Various ways of reaching this quantitative measure of the closeness of such relationships have been suggested. Some are found with a *minimum* of labour but it is unfortunately the case that the simpler the method, the less the reliance we can place on the result.

In dealing with these data in the Report, Dr Branthwaite has used exclusively the "method of percentages," and it must be frankly stated that the use of this method in the present case can only mislead since the values obtained depend on the way in which the material is divided. Whatever be the actual relationship we can, in fact, obtain as small a value as we please for the relationship by the method of percentages, by dividing the material in special ways.

How misleading the method of comparing percentages or proportions may be, can be seen from the following example taken from a recent Text-book on Statistical Methods* where this method is unfortunately recommended. It is used to investigate the relationship between deaf-mutism and imbecility†. The facts expressed in tabular form are as follows:

TABLE XIII.

Class	Deaf-mute	Not Deaf-mute	Totals
Imbecile	451	48,431	48,882
Not Imbecile......	14,795	32,464,323	32,479,118
Totals	15,246	32,512,754	32,528,000

From this table the author finds that:

"the proportion of imbeciles among deaf-mutes was 29·6 per thousand,
and the proportion of imbeciles in the whole population was 1·5 per thousand,"

or otherwise:

"the proportion of deaf-mutes among the imbeciles was 9·2 per thousand,
and the proportion of deaf-mutes in the whole population was 0·5 per thousand."

He then states that "either comparison exhibits very clearly the high degree of association between the attributes." Now the difference between the proportions is

* G. Udny Yule: *An Introduction to the Theory of Statistics*, pp. 30, *et seq.*

† Mr Yule warns the reader that the data in this case are not quite trustworthy but ignores the fact that a far greater error is introduced by his method of measuring the association between the characters concerned.

in the one case 28·1 per 1000 and in the other 8·7 per 1000, and the fact that these values are not the same is sufficient to condemn the method. There are however more serious objections to its use. The closest possible relationship between deaf-mutism and imbecility would exist if all imbeciles, and none others, were deaf-mute. Then the proportion of imbeciles among deaf-mutes would be 1000 per 1000 and among those who are not deaf-mutes, 0 per 1000, so that the maximum difference is 1000 per 1000. On the other hand, if there were *no* relationship between imbecility and deaf-mutism, the proportion of imbeciles would be the same among the deaf-mutes as among those who are not deaf-mutes, so that the difference between the proportions would be nil. In the example given the difference is actually 28 per 1000 so that this relationship is ·028 up the scale of association, which hardly indicates a "high degree of association." If we consider rows instead of columns, we get a coefficient of ·009, still very small. How then does the author come to the conclusion that this table exhibits a "very high degree of association"? The answer is a simple one; although this table is given to illustrate the method of proportions, he has actually estimated the closeness of the relationship by another equally simple and equally erroneous method, and has used the coefficient of association. With the method of proportions, we can obtain as *small* a value as we please; with the coefficient of association, as *large* a value as we please. Thus the method of proportions gives coefficients of ·028 and ·009* while the coefficient of association is ·91. There are doubtless statisticians who find that the property of these coefficients of assuming *any* value is of some advantage but their inclusion in a text-book on statistical methods is decidedly unfortunate.

The method of comparing averages suffers from the same defect. This method is usually applied to cases where one character is quantitative and the other is qualitative. We find, for instance, that inebriates described as of good mental condition had an average of 15·4 previous convictions while those who were mentally defective had an average of 28·8, a difference of 13·4 convictions. What meaning are we to attach to this difference? Does this represent a close or only a slight relationship? Does this difference, like the coefficient of association, vary according to the way in which the material is divided? This can at once be answered by dividing the material in another way, taking the insane and very defective together and comparing their convictions with those of the defective and of average mental condition. In this case the difference between the averages is 20, when the division was taken between the defective and those of average mental condition the difference was 13·4, so that here again we have a method which depends to a very large extent on the way in which the material is divided.

How then are these relationships to be measured? The standard method is the correlation coefficient. This can be used directly in all cases where both characters are quantitative, provided that the regression is linear; if the regression be not linear, then the correlation ratio should be used. In dealing with qualitative characters the

* The square root of the product of these two coefficients gives Mr Yule's "theoretical value of r."

coefficient used must depend on the nature of the distributions, and experience shows that qualitative characters in man tend to follow more or less closely the normal curve of error, approximate to the "cocked-hat" type of curve. Further, there are so very few distributions for which the normal curve cannot be considered as a first approximation that in the absence of any information regarding the real nature of the distributions, we may safely assume that the coefficients obtained on this assumption will be approximately correct, and whatever the nature of the distributions, the coefficients of correlation obtained in this way can still be regarded as "coefficients of association."

The correlation coefficient is zero when the two characters under consideration are independent and unity, when the relationship is one of perfect dependence. If large values of one character are associated with large values of the other, the correlation coefficient has the positive sign; while if large values of one are associated with small values of the other, the correlation is negative, and may thus range from -1 to $+1$.

The correlation ratio is essentially without sign but it is usual and convenient to determine signs in this case also. The method adopted here is to suppose that the direction, worse to better, in the case of any qualitative character such as mental condition or conduct, is the positive direction. Hence when we find that the more intelligent inebriates behave better, we give to the relationship the positive sign.

No difficulty arises with quantitative characters such as age, number of convictions, etc., and when dealing with qualitative characters we naturally consider those who are mentally defective, physically unfit, badly educated, have records of organic disease, of fits or *delirium tremens* as worse than those who are of average mental capacity, physically fit, well educated and with no histories of organic disease, fits or *delirium tremens*. When we deal with the classification of the inebriates into regular or periodic drinkers, there is less to guide us; but throughout the present memoir it has been assumed that regular drinkers are, for the purpose of determining signs of correlation cofficients, "worse" than periodic drinkers. The distinction is of course purely conventional. A positive correlation between mental condition and conduct will thus indicate that the more intelligent inebriates behave better than the mentally defective inebriates, while a negative correlation between morality and number of convictions indicates that the immoral have more convictions than the moral.

No attempt has been made however to give signs in the case of civil status or occupation. Widows, for instance, can be placed with single women so far as morality is concerned; when considering their ages, however, we find that they are at opposite ends of the scale. It is thus impossible to obtain a consistent method of assigning signs to the correlation coefficients. The values given merely indicate departures from independence and, when looked at from this point of view, give valuable information.

In addition to discussing the direct relationships between pairs of characters, it will often be necessary to examine the mutual relationships between three or even four characters. Perhaps an example will best show how this necessity arises.

In his Report (p. 39) Dr Branthwaite discusses the relation between physical fitness and the duration of the alcoholism. This relationship is expressed in percentages as follows (Table J of the Report):

TABLE XIV.

Condition	Years addicted to drunkenness						Totals
	5 and under	6—10	11—20	21—30	31—40	41—50	
Fit	96	216	214	38	7	—	571
Unfit	30	104	130	24	5	1	294
Totals	126	320	344	62	12	1	865
Percentages of unfit to totals	23·81	32·50	37·79	38·71	41·67	100·00	33·99

Dr Branthwaite then argues that "the figures also demonstrate the influence of continued drunkenness and the life associated with drunkenness in the making of the unfit. The definite and regular increase in the percentage of the unfit with every additional decade of habitual drunkenness is unmistakeable."

This table furnishes another striking example of the danger of using the method of proportions in estimating these relationships, for the actual correlation between physical fitness and duration of alcoholism is only $-\cdot 17$. We cannot however assert that even this low value of the correlation coefficient represents the effect of long continued alcoholism on the physique of these inebriates, because it is obvious that apart from any question of alcoholism the number of women who are unfit for hard work will naturally increase with age, and that a woman with a record of over 30 years of drunkenness will naturally be considerably older than the woman with less than 5 years of drunkenness. It is perhaps hardly necessary to show that physical unfitness increases with age. I have given, however, in Fig. 4, for members of the Manchester Unity Friendly Society, the average number of weeks of sickness at different ages. Between 20 and 30, the curve is nearly horizontal and this is due to the medical examination on entrance to the Society which cuts out all the unfit. Every man must have reached a certain definite standard of health before being admitted to the Society. After age 30, however, the number of weeks of sickness increases steadily with age, showing that the amount of physical unfitness increases with age. These men of course are a selected body and there is at present no sickness experience with which that of the inebriates might be compared. The experience of the Post Office section of the contributors under the Insurance Act will probably give the fairest comparison.

It is clear then that, in determining the effect of long continued alcoholism on the physique of the inebriates, it is necessary that we should eliminate the effect of age. This is done by means of a *partial correlation coefficient* which measures the

relationship between the duration of alcoholism and the physique of these inebriates, for a constant age.

We have seen that the *direct* correlation between the duration of alcoholism and the physical condition is $-\cdot 17$*. On the other hand the correlation between age and physical condition is $-\cdot 46$ and that between age and duration of alcoholism is $+\cdot 42$. From these values we find that:

$$\left.\begin{array}{l}\text{the correlation between duration of alcoholism}\\ \qquad\text{and physique for a constant age is}\end{array}\right\} + \cdot 04,$$

$$\left.\begin{array}{l}\text{while the correlation between age and physique}\\ \qquad\text{for constant duration of alcoholism is}\end{array}\right\} - \cdot 44.$$

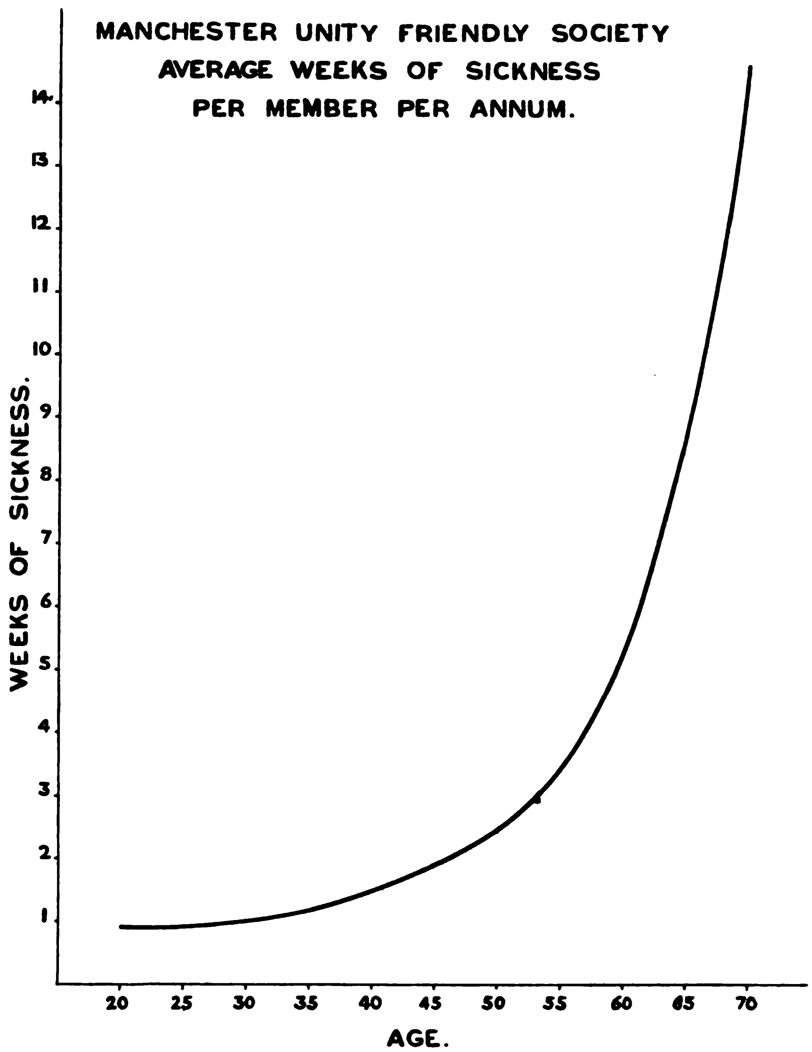

FIG. 4.

Thus duration of alcoholism, independent of age, has *no* effect on physique; while age, independent of duration of alcoholism, has a *very marked* effect. If it be objected that this might be due to the elimination of all the weaker inebriates before the later ages are reached, while the older inebriates are merely those who started to drink late in life, it should be noted that the average duration of alcoholism for all

* On the assumption that the distribution of physical condition is approximately Gaussian.

inebriates is 12·1 years, while among those who are at least 55 years of age it is 18·5 years, and this gives no support to such a view.

The importance of these partial correlation coefficients in this as in every branch of social investigation is so great that it seems desirable that some illustrations of their use should be given directly from the data. Table II in the Appendix gives the relationship between age and duration of alcoholism. If we deal with successive *columns*, we get the distribution of duration of alcoholism among groups of inebriates who are, within narrow limits, of the same ages, while if we consider successive *rows*, we get the distribution of age among inebriates whose alcoholism has lasted the same length of time. We can now go a step further and break up the numbers in each cell into the fit and the unfit. We can thus find from the columns the average duration of alcoholism of fit and unfit among inebriates who are of constant age*, while from the rows we get the average ages of inebriates with the same duration of alcoholism.

Using all the rows and columns from which averages may safely be calculated, we get:

TABLE XV. (*a*) *Age Constant.*

Ages	Average duration of Alcoholism		Differences (Years)
	(i) among the fit	(ii) among the unfit	
25–	8·530	8·462	+ ·068
28–	10·488	10·352	+ ·136
31–	11·148	11·084	+ ·064
34–	11·924	13·358	−1·434
37–	12·742	15·714	−2·972
40–	13·448	13·352	+ ·096
43–	14·716	13·428	+1·288
46–	13·454	14·250	− ·796
49–	16·874	13·904	+2·970
52–	14·308	12·600	+1·708

(*b*) *Duration of Alcoholism Constant.*

Duration of Alcoholism	Average ages		Differences (Years)
	(i) among the fit	(ii) among the unfit	
5	35·236	40·963	−5·727
7	34·606	41·038	−6·432
9	34·858	42·949	−8·091
11	36·175	42·583	−6·408
13	36·319	40·252	−3·933
15	37·795	45·358	−7·563
17	39·142	43·117	−3·975
19	42·082	48·205	−6·123

* There is of course some variation *within* the three-year age groups, but this is small and for present purposes may be neglected.

We see then that when we take age constant, the differences between the average duration of alcoholism among fit and unfit are all small. It is essential to notice that *every* difference is small; if we sum up the results by means of an average of these differences, when we take constant ages, the average duration of alcoholism among the fit is ·113 years, or about six weeks, longer than among the unfit. This corresponds to a partial correlation coefficient of $+ \cdot 04$. On the other hand, when we make duration of alcoholism constant, we find that the average age of the unfit is 6·042 years greater than that of the fit, corresponding to a partial correlation coefficient of $- \cdot 44$. We see then that the increase in the percentage of the unfit with every additional decade of drunkenness is merely an indirect effect of age.

The point is so important that it has been further illustrated graphically. In Fig. 5 we have the relationship between age and physical fitness. At 16 years of age less than 10 °/ₒ of the inebriates are unfit for hard work and the percentage rises steadily until at 70 over 95 °/ₒ are unfit for hard work. In Fig. 6 the continuous line gives the relationship between duration of alcoholism and physical unfitness. Figs. 5 and 6 are drawn so that they may be directly compared, and it is at once seen that the relationship between physique and age is much closer than that between physique and duration of alcoholism. The dotted line in Fig. 6 shows how much of the latter relationship is due to the indirect effect of age. It was reached in the following way. I calculated in turn the average ages of the women in each duration of alcoholism group. From Fig. 5 I then obtained the percentages of women who are unfit at these ages. This gives the percentage of women who would be unfit independent of duration of alcoholism and these figures were then plotted on the diagram and joined by a dotted line. It is then clear that age is sufficient to account for all the observed relationship. It should be clearly understood that although averages and percentages are given in these illustrations of the use of partial correlation coefficients, as measures of degrees of relationship they are of no value apart from the correlation coefficients and can only be used *after* the latter have been determined.

V. *The Relationship between Alcoholism and Mental Defect in the General Population.*

Before we discuss the relationships between age, number of convictions, mental and physical condition and so forth, among the inebriates, it is desirable that we should consider, just as was done in the "Preliminary Study," the extent to which the inebriates are differentiated from the general population in respect of mental defect.

We must take in the first place a sample of the women of the general population of such a size that it will include, in the proper proportion, 865 convicted inebriates. This sample will then be made up of four classes. We shall have convicted inebriates who are of normal intelligence, convicted inebriates who are mentally defective, and women who are not convicted inebriates, normal and mentally defective. We have already seen that out of 865 inebriates, 311 are normal and 554 are mentally defective.

AGE, DURATION OF ALCOHOLISM, AND PHYSIQUE.

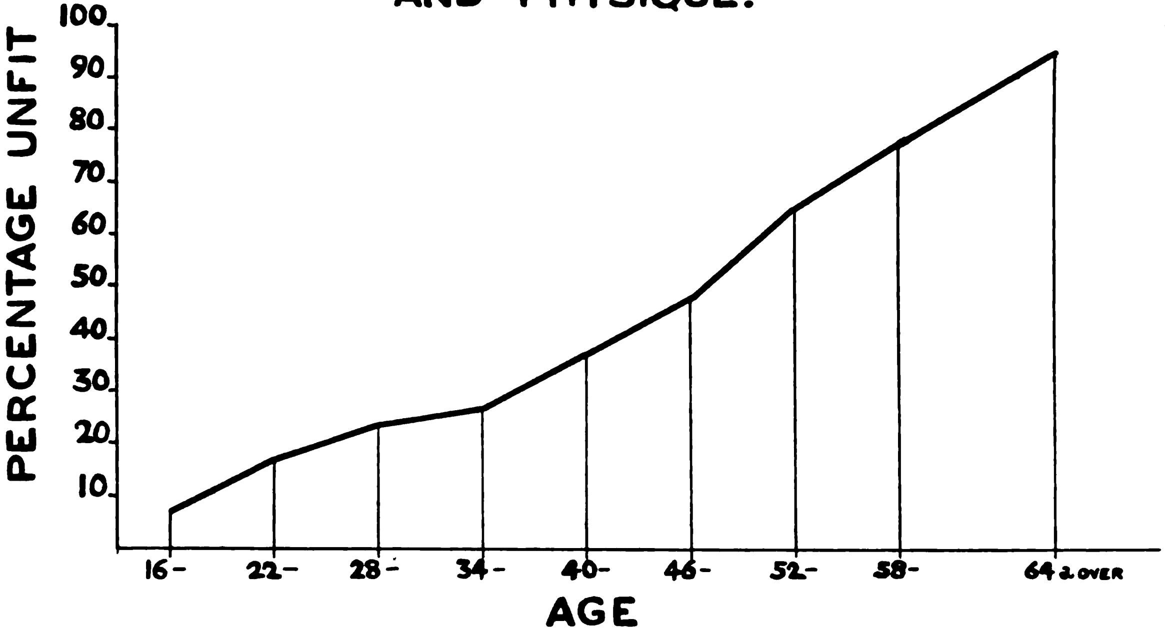

Fig. 5.

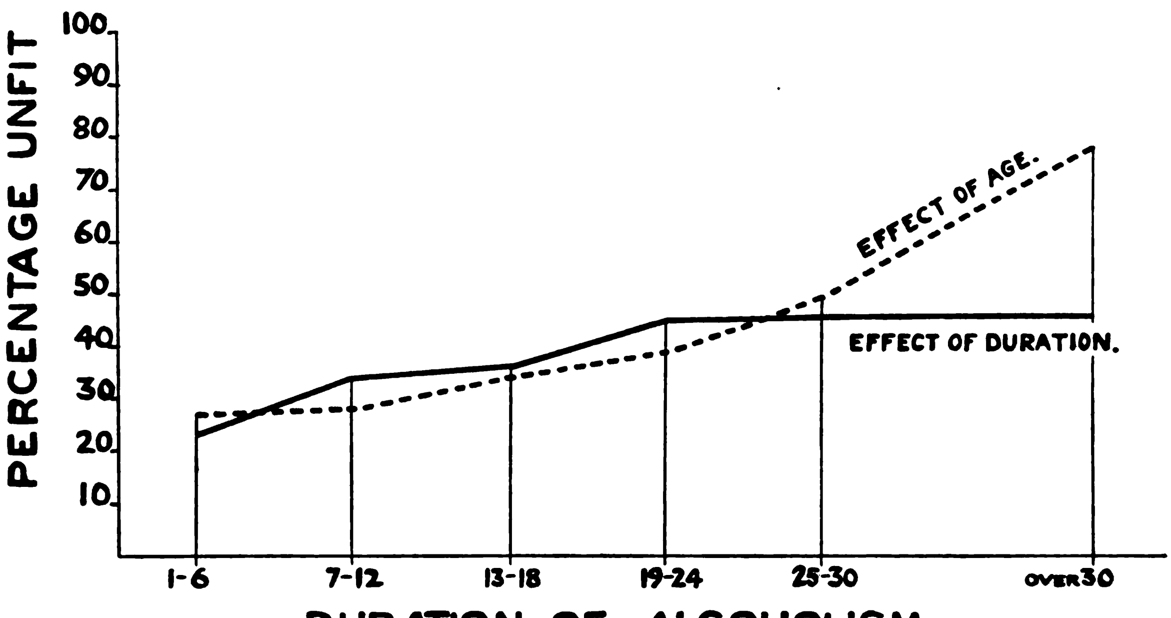

Fig. 6.

We do not know directly the numbers of normal and mentally defective women among those who are *not* inebriates. Let these be x and y, and we can form a fourfold table as follows:

TABLE XVI.

Mentality	Convicted Inebriates	Rest of Population	Totals
Normal	311	x	$311+x$
Mentally defective	554	y	$554+y$
Totals	865	$x+y$	$865+x+y$

It remains to determine the values of x and y. They are not known directly but can be obtained if we know (a) the proportion of mentally defective women in the general population and (b) the proportion of convicted inebriates in the general population. The amount of mental defect in the general population was considered very fully in our "Preliminary Study" on the basis of the statistics of mental defect among school children. It was considered safe to take ·618 °/₀ and 1·09 °/₀, the percentages of mentally defective children in Liverpool and London respectively, as limiting values. In further justification of the use of these figures it may be said that in the Report of the Royal Commission on the Feeble-Minded, it is stated that, in England and Wales, "the total number of mentally defective persons, including certified lunatics, may be estimated to be 271,607 or ·83 °/₀ of the population." In the present investigation I have taken ·5 °/₀ and 1·5 °/₀ as the extreme values, so that there can be no doubt that the actual percentage of mental defect in the general population really lies between these limits.

The determination of the ratio of convicted inebriates to the general population is more troublesome. Let this ratio $\frac{I}{P}=R$. Then it may fairly be assumed that this ratio will be nearly stable and hence that the ratio of the increase in the number of convicted inebriates, less the deaths among the total convicted inebriates, in or out of Reformatories, to the increase in the population from which the inebriates are drawn, will also be equal to R. According to this sample of inebriates, their ages run from 17 to 75. The statistics refer to the period 1st Jan. 1907 to 31st Dec. 1909, so that we can use the year 1908 in estimating the increase of population. The increase in the population between the ages of 17 and 75 is equal to the number of woman aged 16 in 1907 less the number of women aged 75 in 1908, less the number of women aged 16—74 who died in 1908. We thus find that the increase in the population is approximately 202,847.

The increase in the number of convicted inebriates equals the number of new convictions (A_1) less the number of deaths of convicted inebriates in or out of Reformatories. It was found that the average number of new convictions was 274·875. Let $\lambda_2 P$ be the number of deaths in the general population between 17 and 75, $\lambda_1 I$ the number of deaths among convicted inebriates. Then $I=RP$ and $\lambda_1 I=\frac{\lambda_1}{\lambda_2}R\,.\,\lambda_2 P$.

Let $\frac{\lambda_1}{\lambda_2}=K$, the ratio of the death-rate among the convicted inebriates to that among

the general population at the same ages. Now $\lambda_2 P$, the number of deaths in the general population aged 17—75, $=129{,}193$.

Thus $$\lambda_1 I = K \,.\, R \times 129{,}193.$$

Now if the proportion of inebriates in the general population is fairly constant, we shall have that, very nearly,

$$\frac{I}{P} = \frac{\text{Increase of } I}{\text{Increase of } P} = \frac{\delta I}{\delta P} = R;$$

hence $$R = \frac{\delta I - KR \times 129{,}193}{\delta P};$$

$$\therefore\ R = \delta I \div \{202{,}847 + K \,.\, 129{,}193\}.$$

What value are we to assign to K, the ratio of the death-rate among inebriates to the death-rate in the general population? This cannot be determined directly, but we shall be safe in assuming that the true value of K lies between 1 and 2, i.e., that the death-rate among inebriates is not less than that of the general population and not greater than twice that of the general population.

On this assumption we get

$$R = \cdot000{,}827{,}837 \text{ when } K=1,$$

$$R = \cdot000{,}595{,}957 \text{ when } K=2.$$

But the total population between 17 and 75 in 1908 was estimated at 11,439,103;

thus $$I = 9470 \text{ if } K=1$$

or $$= 6817 \text{ if } K=2.$$

It is now possible to complete the fourfold table. We have estimated that the proportion of mentally defective women in the general population is

$$\frac{554+y}{865+x+y} = \text{(i) } \cdot005 \text{ or (ii) } \cdot015$$

and that the ratio of convicted inebriates to the whole is

$$\frac{865}{865+x+y} = (a)\ \cdot000{,}827{,}837 \text{ or } (b)\ \cdot000{,}595{,}957.$$

Combining these two pairs of equations we obtain *four* values for x and y and hence *four* possible fourfold tables.

But the *maximum* correlation will be got by taking the minimum percentage of mental defect with the minimum death-rate among inebriates, while the *minimum* correlation will be obtained when the mental defect and the death-rate among inebriates are at a maximum, and the limits of the correlation will be obtained from these two cases.

We thus obtain the following tables:

TABLE XVII. *Percentage of mental defect* = ·5 °/$_\circ$. $K = 1$.

Mentality	Convicted Inebriates	Rest of Population	Totals
Normal	311	1,039,356	1,039,667
Mentally defective	554	4,670	5,224
Totals	865	1,044,026	1,044,891

TABLE XVIII. *Percentage of mental defect* = 1·5 °/$_\circ$. $K = 2$.

Mentality	Convicted Inebriates	Rest of Population	Totals
Normal	311	1,429,364	1,429,675
Mentally defective	554	21,218	21,772
Totals	865	1,450,582	1,451,447

From these tables we obtain by the usual methods the following tables:

I. $12{\cdot}8694 = r + 4{\cdot}0519\,r^2 + 8{\cdot}3562\,r^3 + 8{\cdot}4657\,r^4 + 2{\cdot}4988\,r^5 - 1{\cdot}1538\,r^6$
$+ 1{\cdot}1166\,r^7 + 1{\cdot}2547\,r^8 - {\cdot}9144\,r^9 + {\cdot}2830\,r^{10} \ldots.$

II. $4{\cdot}7085 = r + 3{\cdot}5165\,r^2 + 5{\cdot}8748\,r^3 + 3{\cdot}7585\,r^4 - 1{\cdot}2900\,r^5 - 1{\cdot}9642\,r^6$
$+ {\cdot}2389\,r^7 \ldots.$

These equations lead to

(1) $r = {\cdot}82 \pm {\cdot}01$, (2) $r = {\cdot}69 \pm {\cdot}01$.

We thus reach the conclusion that, on the assumptions made, the correlation between mental defect and inebriety in the general population lies between ·69 and ·82, and although the assumptions made vary between very wide limits, the extreme values of the resulting correlation coefficients lie within ·13 of each other. These assumptions are probably the most reasonable that can be made in the present state of our knowledge and we are on fairly safe ground in asserting that the relationship between inebriety and mental defect is about ·76. We have thus reached a definite measure of a relationship on which every authority on alcoholism has laid the greatest possible stress. We must not, however, hastily assume that the mental defect is due to the alcoholism, but reserve this, one of the most important questions in the whole study of inebriety, for later consideration.

VI. *The Relationships between the Characters dealt with.*

The correlations between every pair of characters considered are given in Table XIX (pp. 40 and 41), together with their probable errors and the methods by which they have been obtained. The letters, P.M., indicate that the correlation

TABLE XIX. *The Relationships between*

Characters	Age	Age at onset of alcoholism	Duration of alcoholism	No. of convictions	No. of convictions per annum	Mental condition	Education
Age	......	+ ·767 ± ·009 P.M.	+ ·422 ± ·019 P.M.	+ ·169 ± ·022 P.M.	− ·011 ± ·023 P.M.	− ·125 ± ·023 4-row η	− ·154 ± ·022 4-row η
Age at onset of alcoholism	+ ·767 ± ·009 P.M.	......	− ·264 ± ·021 P.M.	− ·215 ± ·022 P.M.	− ·093 ± ·023 P.M.	− ·085 ± ·023 4-row η	+ ·061 ± ·023 4-row η
Duration of alcoholism	+ ·422 ± ·019 P.M.	− ·264 ± ·021 P.M.	......	+ ·559 ± ·016 P.M.	......	− ·180 ± ·022 4-row η	− ·175 ± ·022 4-row η
No. of convictions	+ ·169 ± ·022 P.M.	− ·215 ± ·022 P.M.	+ ·559 ± ·016 P.M.	......	......	− ·352 ± ·020 4-row η	− ·270 ± ·021 4-row η
No. of convictions per annum	− ·011 ± ·023 P.M.	− ·093 ± ·023 P.M.	......	......	......	− ·336 ± ·020 4-row η	− ·190 ± ·022 4-row η
Mental condition	− ·125 ± ·023 4-row η	− ·085 ± ·023 4-row η	− ·180 ± ·022 4-row η	− ·352 ± ·020 4-row η	− ·336 ± ·020 4-row η	......	+ ·548 ± ·029 4-fold r
Education	− ·154 ± ·022 4-row η	+ ·061 ± ·023 4-row η	− ·175 ± ·022 4-row η	− ·270 ± ·021 4-row η	− ·190 ± ·022 4-row η	+ ·548 ± ·029 4-fold r	......
Physical condition	− ·463 ± ·018 Bi-serial r	− ·371 ± ·020 Bi-serial r	− ·167 ± ·022 Bi-serial r	− ·043 ± ·023 Bi-serial r	+ ·050 ± ·023 Bi-serial r	+ ·348 ± ·035 4-fold r	+ ·169 ± ·037 4-fold r
Organic disease	− ·357 ± ·020 5-row η	− ·287 ± ·021 5-row η	− ·126 ± ·023 5-row η	− ·059 ± ·023 5-row η	+ ·058 ± ·023 5-row η	+ ·347 ± ·034 4-fold r	+ ·177 ± ·037 4-fold r
Delirium tremens	+ ·066 ± ·023 Bi-serial r	+ ·184 ± ·022 Bi-serial r	− ·156 ± ·022 Bi-serial r	− ·404 ± ·019 Bi-serial r	− ·328 ± ·020 Bi-serial r	+ ·135 ± ·054 4-fold r	+ ·030 ± ·054 4-fold r
Fits	− ·082 ± ·023 Bi-serial r	− ·025 ± ·022 Bi-serial r	− ·084 ± ·023 Bi-serial r	− ·031 ± ·023 Bi-serial r	+ ·007 ± ·023 Bi-serial r	+ ·323 ± ·058 4-fold r	+ ·353 ± ·057 4-fold r
Conduct	+ ·093 ± ·023 4-row η	+ ·156 ± ·022 4-row η	− ·116 ± ·023 4-row η	− ·213 ± ·022 4-row η	− ·243 ± ·022 4-row η	+ ·460 ± ·033 4-fold r	+ ·280 ± ·037 4-fold r
Civil status	·379 ± ·020 4-row η	·351 ± ·020 4-row η	·163 ± ·022 4-row η	·268 ± ·021 4-row η	·298 ± ·021 4-row η	·110 ± ·023 Bi-serial η	·064 ± ·023 Bi-serial η
Occupation	·214 ± ·022* 3-row η	·230 ± ·022* 3-row η	·191 ± ·022* 3-row η	·261 ± ·021* 3-row η	·284 ± ·021* 3-row η	·120 ± ·023 Bi-serial η	·085 ± ·023 Bi-serial η
Morality	+ ·410 ± ·019 Bi-serial r	+ ·483 ± ·018 Bi-serial r	+ ·071 ± ·023 Bi-serial r	− ·309 ± ·021 Bi-serial r	− ·357 ± ·020 Bi-serial r	+ ·098 ± ·037 4-fold r	− ·007 ± ·037 4-fold r
Regular or periodic drinking	− ·080 ± ·023 Bi-serial r	− ·134 ± ·022 Bi-serial r	+ ·065 ± ·023 Bi-serial r	+ ·075 ± ·023 Bi-serial r	+ ·131 ± ·023 Bi-serial r	− ·127 ± ·038 4-fold r	− ·044 ± ·038 4-fold r

* A correlation ratio based on *three* columns is hardly justifiable, but no satisfactory method of dealing with material classified in this way is yet available. In order to test what reliance is to be placed on these values, I have calculated contingency coefficients, based on 5 × 3-fold tables, with the following results:—Age: ·224, Age at onset: ·223, Duration: ·196, Convictions: ·338, Convictions per annum: ·329. These values are on the whole in good agreement with those found by the 3-row η method.

the Characters in Pairs.

Physical condition	Organic disease	Delirium tremens	Fits	Conduct	Civil status	Occupation	Morality	Regular or periodic drinking
− ·463 ± ·018 Bi-serial *r*	− ·357 ± ·020 5-row η	+ ·066 ± ·023 Bi-serial *r*	− ·082 ± ·023 Bi-serial *r*	+ ·093 ± ·023 4-row η	·379 ± ·020 4-row η	* ·214 ± ·022 3-row η	+ ·410 ± ·019 Bi-serial *r*	− ·080 ± ·023 Bi-serial *r*
− ·371 ± ·020 Bi-serial *r*	− ·287 ± ·021 5-row η	+ ·184 ± ·022 Bi-serial *r*	− ·025 ± ·022 Bi-serial *r*	+ ·156 ± ·022 4-row η	·351 ± ·020 4-row η	* ·230 ± ·022 3-row η	+ ·483 ± ·018 Bi-serial *r*	− ·134 ± ·022 Bi-serial *r*
− ·167 ± ·022 Bi-serial *r*	− ·126 ± ·023 5-row η	− ·156 ± ·022 Bi-serial *r*	− ·084 ± ·023 Bi-serial *r*	− ·116 ± ·023 4-row η	·163 ± ·022 4-row η	* ·191 ± ·022 3-row η	+ ·071 ± ·023 Bi-serial *r*	+ ·065 ± ·023 Bi-serial *r*
− ·043 ± ·023 Bi-serial *r*	− ·059 ± ·023 5-row η	− ·404 ± ·019 Bi-serial *r*	− ·031 ± ·023 Bi-serial *r*	− ·213 ± ·022 4-row η	·268 ± ·021 4-row η	* ·261 ± ·021 3-row η	− ·309 ± ·021 Bi-serial *r*	+ ·075 ± ·023 Bi-serial *r*
+ ·050 ± ·023 Bi-serial *r*	+ ·058 ± ·023 5-row η	− ·328 ± ·020 Bi-serial *r*	+ ·007 ± ·023 Bi-serial *r*	− ·243 ± ·022 4-row η	·298 ± ·021 4-row η	* ·284 ± ·021 3-row η	− ·357 ± ·020 Bi-serial *r*	+ ·131 ± ·023 Bi-serial *r*
+ ·348 ± ·035 4-fold *r*	+ ·347 ± ·034 4-fold *r*	+ ·135 ± ·054 4-fold *r*	+ ·323 ± ·058 4-fold *r*	+ ·460 ± ·033 4-fold *r*	·110 ± ·023 Bi-serial η	·120 ± ·023 Bi-serial η	+ ·098 ± ·037 4-fold *r*	− ·127 ± ·038 4-fold *r*
+ ·169 ± ·037 4-fold *r*	+ ·177 ± ·037 4-fold *r*	+ ·030 ± ·054 4-fold *r*	+ ·353 ± ·057 4-fold *r*	+ ·280 ± ·037 4-fold *r*	·064 ± ·023 Bi-serial η	·085 ± ·023 Bi-serial η	− ·007 ± ·037 4-fold *r*	− ·044 ± ·038 4-fold *r*
......	+ ·685 ± ·024 4-fold *r*	− ·108 ± ·054 4-fold *r*	+ ·249 ± ·059 4-fold *r*	+ ·026 ± ·039 4-fold *r*	·261 ± ·021 Bi-serial η	·147 ± ·022 Bi-serial η	− ·189 ± ·036 4-fold *r*	− ·063 ± ·038 4-fold *r*
+ ·685 ± ·024 4-fold *r*	......	− ·123 ± ·053 4-fold *r*	+ ·305 ± ·057 4-fold *r*	+ ·074 ± ·038 4-fold *r*	·203 ± ·022 Bi-serial η	·120 ± ·023 Bi-serial η	− ·111 ± ·036 4-fold *r*	− ·030 ± ·038 4-fold *r*
− ·108 ± ·054 4-fold *r*	− ·123 ± ·053 4-fold *r*	......	+ ·049 ± ·089 4-fold *r*	+ ·177 ± ·055 4-fold *r*	·113 ± ·023 Bi-serial η	·130 ± ·023 Bi-serial η	+ ·108 ± ·053 4-fold *r*	− ·053 ± ·055 4-fold *r*
+ ·249 ± ·059 4-fold *r*	+ ·305 ± ·057 4-fold *r*	+ ·049 ± ·089 4-fold *r*	......	+ ·198 ± ·062 4-fold *r*	·191 ± ·022 Bi-serial η	·127 ± ·023 Bi-serial η	− ·091 ± ·061 4-fold *r*	− ·079 ± ·063 4-fold *r*
+ ·026 ± ·039 4-fold *r*	+ ·074 ± ·038 4-fold *r*	+ ·177 ± ·055 4-fold *r*	+ ·198 ± ·062 4-fold *r*	......	·118 ± ·023 Bi-serial η	·094 ± ·023 Bi-serial η	+ ·144 ± ·037 4-fold *r*	− ·087 ± ·039 4-fold *r*
·261 ± ·021 Bi-serial η	·203 ± ·022 Bi-serial η	·113 ± ·023 Bi-serial η	·191 ± ·022 Bi-serial η	·118 ± ·023 Bi-serial η	......	·621 ± ·023 Contingency	·656 ± ·013 Bi-serial η	·107 ± ·023 Bi-serial η
·147 ± ·022 Bi-serial η	·120 ± ·023 Bi-serial η	·130 ± ·023 Bi-serial η	·127 ± ·023 Bi-serial η	·094 ± ·023 Bi-serial η	·621 ± ·023 Contingency	......	·643 ± ·013 Bi-serial η	·115 ± ·023 Bi-serial η
− ·189 ± ·036 4-fold *r*	− ·111 ± ·036 4-fold *r*	+ ·108 ± ·053 4-fold *r*	− ·091 ± ·061 4-fold *r*	+ ·144 ± ·037 4-fold *r*	·656 ± ·013 Bi-serial η	·643 ± ·013 Bi-serial η	......	− ·169 ± ·037 4-fold *r*
− ·063 ± ·038 4-fold *r*	− ·030 ± ·038 4-fold *r*	− ·053 ± ·055 4-fold *r*	− ·079 ± ·063 4-fold *r*	− ·087 ± ·039 4-fold *r*	·107 ± ·023 Bi-serial η	·115 ± ·023 Bi-serial η	− ·169 ± ·037 4-fold *r*	......

* See footnote p. 40.

has been calculated by the ordinary product moment method. Where the method applied is the usual form of the correlation ratio, the symbols 3-, 4-, 5-row η have been used, according to the number of arrays available. Professor Pearson's four-fold table method is denoted by "4-fold r" and depends on the assumption that the distribution is approximately Gaussian. "Bi-serial r" and "bi-serial η" refer to the two new methods of calculating the correlation given by Professor Pearson*. Both assume an approximately normal distribution of the character which is given in alternate categories, while the second also assumes that the arrays are homoscedastic. The probable errors of the coefficients calculated by the four-fold table method were obtained from new tables calculated by Professor Pearson, to be published in the next number of *Biometrika*. In the other cases, the ordinary formula, $\frac{\cdot 67449\,(1-r^2)}{\sqrt{n}}$, has been used. This gives too low a value when the coefficients have been calculated by either of the bi-serial methods, but the actual formulae in those cases have not yet been determined. This must of course be taken into account in determining the significance of small correlations calculated by these methods.

Attention must again be drawn to the fact that in certain cases these coefficients are not strictly comparable with each other unless the assumptions made as to the nature of the distributions are approximately true; but whatever the nature of these distributions, the coefficients given can still be regarded as "coefficients of association," to use that much-abused term. A coefficient of zero always denotes that there is complete independence between the characters concerned while large values of these coefficients denote that there are large divergences from independence.

In Table XX, I have placed together, for reference, the means and standard deviations of the quantitative characters, together with their probable errors.

TABLE XX. *Means and Standard Deviations of Quantitative Characters.*

Character	Means	Standard Deviations
Age on admission	$39{\cdot}09 \pm {\cdot}23$	$10{\cdot}08 \pm {\cdot}16$
Age at onset of alcoholism	$26{\cdot}98 \pm {\cdot}22$	$9{\cdot}51 \pm {\cdot}15$
Duration of alcoholism	$12{\cdot}06 \pm {\cdot}15$	$6{\cdot}65 \pm {\cdot}11$
Total number of convictions	$23{\cdot}95 \pm {\cdot}51$	$22{\cdot}38 \pm {\cdot}36$
Annual number of convictions	$2{\cdot}06 \pm {\cdot}03$	$1{\cdot}43 \pm {\cdot}02$

(*a*) *Age on Admission to Reformatory.* The correlations involving age on admission to the Reformatories present many interesting features. The high

* "On a new method of determining correlation between a measured character A, and a character B, of which only the percentage of cases wherein B exceeds (or falls short of) a given intensity is recorded for each grade of A," *Biometrika*, vol. VII. p. 96; and "On a new method of determining correlation when one variable is given by alternative and the other by multiple categories," *Biometrika*, vol. VII. p. 248.

correlations with the age at onset of alcoholism and the duration of the alcoholism should be noted, but it must be remembered that these high values arise to a certain extent from the nature of the characters considered since the sum of the age at onset and the duration of alcoholism give the age on admission, and thus we get spurious *positive* correlations. The low correlation (+·169) between age on admission and the total number of previous convictions is noteworthy. Although the correlation is small it represents a definite relationship. The means of the arrays increase slowly but steadily, as is seen in the following table:—

TABLE XXI.

Age	Average number of convictions	Age	Average number of convictions
16–	15·5	40–	27·0
22–	18·2	46–	25·1
28–	21·1	52–	27·4
34–	23·3	58–	36·2

The average number of previous convictions for all ages is 24. The regression is very nearly linear, the correlation ratio, based on eight columns, is +·182 or only ·013 greater than the correlation coefficient, a difference which is considerably less than its probable error*. The low value of the correlation is due to the fact that the age on admission is made up of two parts, one of which we may term pre-alcoholic, and the other alcoholic. The pre-alcoholic part, before the onset of alcoholism, contributes nothing to the number of convictions and thus the correlation is small.

The relation between the age on admission and the number of convictions per annum is practically zero (−·011) and indicates that those inebriates are not convicted more frequently with advancing age. This point will be discussed more fully however in dealing with the duration of alcoholism. The small negative correlation between age and mental condition indicates that the mental condition of the inebriates gets slightly worse with age, but the correlation is so small that little stress can be laid upon it. Actually we find that there is only a difference of two years in the average ages of those said to be of good mental condition and those who are mentally defective, although the ages range from 17 to 75. In the same way there is a small negative correlation of −·154 between age and education, showing that the older inebriates have a slightly worse education than the younger. If we take out the percentages of inebriates who can neither read nor write, we find that there is a gradual increase with age. The results are given in the following table:—

* When the regression is linear, the correlation coefficient and correlation ratio have the same value.

TABLE XXII.

Age	Percentage of illiterate inebriates
16–	8·9
31–	11·1
40–	12·9
49–	20·9
58–	28·6
All ages ...	12·9

There is no need, however, to assign the increase to the effects of alcoholism. The figures already given showing the steady decrease in the amount of illiteracy during the last fifty years among those who marry indicate that the larger proportion of illiterates among the older generation, inebriate or non-inebriate, is to be assigned to the want of educational facilities.

The relationship between age and physical condition is, on the other hand, much closer as is also that between age and organic disease. The percentage of inebriates who are unfit for hard work rises steadily from 6·3 °/₀ among those who are under 22 to 86·2 °/₀ among those who are over 60, while in the same way the percentage of inebriates with some organic disease rises from 12·5 °/₀ among those who are under 22 to 89·7 °/₀ among those who are over 60. It has already been shown, however, that we must not hastily assume that alcoholism plays any part in producing this increase in physical unfitness.

The correlations between age and *delirium tremens*, fits and regular or periodical drinking are very small, and although they may be considered barely significant if we look only to the relative values of correlation coefficient and probable error, the absolute values of these coefficients are so small that for purposes of prediction they are useless. The relation of age to civil status and occupation will be considered more fully later, but it may be noted that the coefficients given, ·379 and ·214, show that there is considerable variation in those characters in regard to age. The comparatively high correlation between age and morality (+·410) shows that the "immoral,"—practically those who are known to have been convicted of prostitution or allied offences,—are much younger than the "moral." Actually the difference between the average ages of these two classes is nearly 12 years and this must be taken into account in interpreting the many high correlations involving morality.

(*b*) *Age at Onset of Alcoholism.* The high correlation between age on admission and age at onset of alcoholism has already been shown to be largely spurious and this also applies to the negative correlation between the age at onset and the duration of the alcoholism. The fact that there is a natural limit to the sum of these two quantities and that we can thus only increase one at the expense of the other gives

rise to a spurious *negative* correlation, and this is also true, though rather indirectly, of the correlation with the number of convictions. The correlations with mental condition, education, physical condition and organic disease are rather smaller than the correlations between these characters and the age on admission. There is somewhat unexpectedly a significant positive correlation between the age at onset of alcoholism and *delirium tremens*; those who have had *delirium tremens* started to drink rather later (2·9 years) than those who have not suffered in this way. Now it is almost certain that there is a much higher death-rate among those who have had *delirium tremens* than among inebriates generally, and this selective action may possibly account for the positive correlation. Those who give most trouble in the Reformatories started to drink at a rather earlier age than the well-behaved, the correlation ratio being + ·156. This is reduced to + ·100, however, when we allow for morality. The relationships between age at onset of alcoholism and civil status and occupation are practically the same as the correlations of these characters with the age on admission. There is a marked relationship between the age at onset of alcoholism and morality, and on comparing the averages we find that the immoral begin to drink 7·3 years before the moral. Those who drink regularly begin to drink at a slightly earlier age than those who drink periodically but the difference is small, only one year.

(*c*) *The Duration of the Alcoholism.* The relationships between the duration of alcoholism and the age on admission and the age at onset of alcoholism have already been discussed and the point which next attracts attention is the close relationship between the duration of alcoholism and the total number of previous convictions (correlation = + ·559). If we had been able to take the onset of alcoholism from the date of the first conviction and had been able to allow for the periods spent in prison or in Reformatories, periods during which conviction is obviously impossible, the correlation would have been still higher. If we calculate the average number of convictions for various periods of alcoholism, we find that there is a steady rise in the average number of convictions as the duration of alcoholism increases. The results are given in the next table:—

TABLE XXIII.

Duration of Alcoholism	Average number of convictions	Duration of Alcoholism	Average number of convictions
*1—2	5·6	15—16	31·0
3—4	8·9	17—18	32·8
5—6	10·3	19—20	40·1
7—8	14·5	21—22	51·4
9—10	18·6	23—24	56·2
11—12	23·3	25—26	44·9
13—14	30·1	27 & upwards	60·4

* The group 1—2 years extends from 6 months to 2 years 6 months, the mid-point being at 1 year 6 months.

The general average is 24 convictions. These results are also given graphically in Fig. 7 and it will be seen that the regression is very nearly linear. Now at the onset of alcoholism there are, of course, no convictions and the duration of alcoholism is *nil*; the average number of convictions is 23·95 and the average duration of alcoholism is 12·06 years. If then we draw a straight line through the origin which represents convictions *nil* and duration of alcoholism *nil*, and through the point which represents the mean number of convictions and the mean duration of alcoholism, we

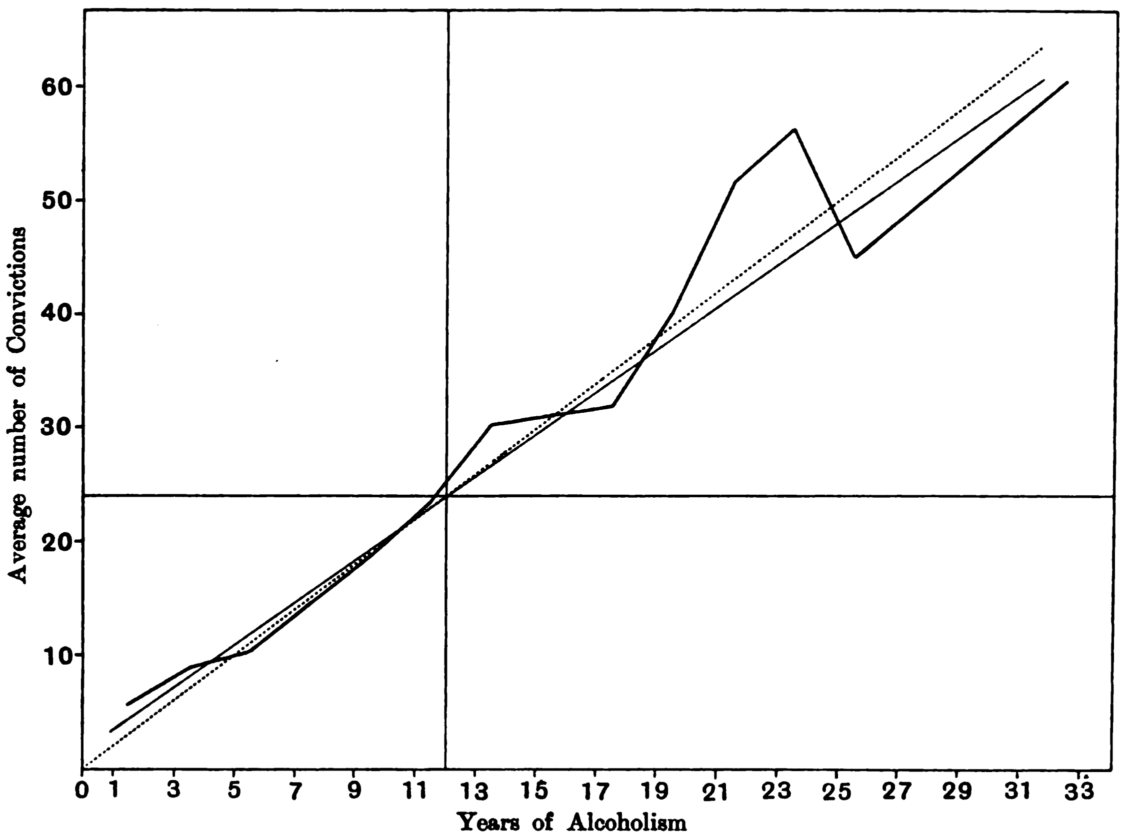

FIG. 7. DIAGRAM SHOWING THE AVERAGE NUMBER OF CONVICTIONS AFTER VARIOUS PERIODS OF ALCOHOLISM.

obtain a graphical representation of a regular increase in the number of convictions through every year of alcoholism. It will be seen that this line (the dotted line in Fig. 7) lies very close to the (continuous) regression line and thus there is practically a uniform increase in the number of convictions with every additional year of alcoholism, i.e. convictions do not become markedly more frequent as the duration of alcoholism is longer. The difficulty in obtaining *complete* records of the previous convictions of inebriates who have been drinking for many years must of course be noted.

There is considerable difficulty in dealing with the relationship between the duration of alcoholism and the number of convictions per annum from the present data since the direct correlation between these characters gives at once a large *negative* spurious correlation. It would have been of considerable advantage to have

given the total number of convictions during the last two or three years before committal to a Reformatory. The correlation between this number and the duration of alcoholism could have been calculated directly and would have yielded interesting results. In the absence of this information, however, we may make use of the diagram just given (Fig. 7) which shows the average number of previous convictions for various periods of alcoholism. If there were any significant increase in the annual number of convictions with the duration of alcoholism, we should expect that the regression line would assume a logarithmic form, that not only would the average number of convictions increase with the duration of alcoholism but also that the rate of increase would increase. The diagram gives no support to such a belief since the regression is very nearly linear.

Some further light on this point is given in Dr Branthwaite's Report for 1906 (p. 62), where there is given the prison history of a female inebriate previous to her committal to a Reformatory. Her first conviction dates from 28th Jan. 1881 when she was 15 years 9 months old. Up to the beginning of 1906 she had been convicted 115 times in all. The distribution of those offences is shown in the following table:—

TABLE XXIV.

Year	Number of convictions	Year	Number of convictions
1881	7	1894	8
1882	2	1895	2
1883	4	1896	2
1884	5	1897	4
1885	5	1898	4
1886	7	1899	6
1887	6	1900	8
1888	7	1901	3
1889	4	1902	—
1890	3	1903	2
1891	10	1904	1
1892	6	1905	3
1893	5	1906	1

The first conviction was on 28th Jan. 1881 and the last on 29th Jan. 1906, so that these 115 convictions fall in 25 years. In 1895, for attempting to steal a watch and chain from the person, she received a sentence of 15 months hard labour, in 1901 she was committed to an Inebriates Home for 2 years, and in 1906 she was committed to an Inebriate Reformatory for 3 years. Unfortunately the actual time spent in prison is not given. The sentences in the later years appear to be somewhat longer than in the earlier years but, even allowing for this, there cannot be said to be

any marked increase in the number of convictions per annum. The nature of the record of this inebriate in 1881 when she was only 16 years of age does not differ in any essential particular from those of subsequent years. Thus her first three convictions in 1881 were for being drunk and disorderly and the sentences were 2*s*. 6*d*. or 1 day, 2*s*. or 4 days, 10*s*. or 7 days. In 1905, 24 years afterwards, she was convicted three times of having been drunk, disorderly, and obscene and the sentences were 2*s*. 6*d*. or 3 days, 7*s*. 6*d*. or 5 days, and 14 days hard labour. Out of the whole 115 offences, we find 36 cases of "drunk and disorderly," and 28 of "drunk and obscene," while 87 in all directly involve drunkenness. It seems clear that these women do not get markedly worse with age or with duration of alcoholism; they begin to drink in a very large number of cases at the earliest age at which they can obtain access to alcohol.

There are small negative correlations between the duration of alcoholism and mental condition (−·180) and education (−·175), but little stress can be laid upon them. We find that the alcoholism of those who are mentally defective has lasted 18 months longer than in the case of those who are of average mental capacity, while those who have a good education have been drinking for 18 months less than those who have a poor education, or none. There are small negative correlations between the duration of alcoholism and physical condition (−·167), organic disease (−·126), and *delirium tremens* (−·156). The relationships with fits, conduct, morality and regular or periodic drinking are barely significant, while those with civil status and occupation which are rather closer will be considered later.

(*d*) *Number of previous Convictions*. The correlations between the number of previous convictions and the age on admission, the age at onset of alcoholism and the duration of the alcoholism have already been considered. The most striking feature of the correlations involving the number of previous convictions is the fairly close relationship with *mental* characters and the absence of any significant relationship with physical characters. Thus there is a correlation of −·352 with mental condition, and the negative sign indicates that the worse the mental condition the greater the number of previous convictions. Similarly there is a correlation of −·270 with education, showing that those whose education is poor have more convictions than those with a good education. If we take averages to illustrate these correlations we find that those who are of good mental condition have an average of 15·3 previous convictions while the inebriates who are mentally defective have an average of 28·8 convictions, a difference of 13·5 convictions.

On the other hand, when we deal with physical characters we find that the correlation between the number of previous convictions and the physical condition of the inebriates, judged by their capacity for hard work, is −·043 which is less than twice its probable error and is consequently not significant. Taking averages to illustrate this we find that the average number of convictions of those who are fit for hard work is 23·4, while that of those who are not fit for hard work is 25·0, a difference of only 1·6 convictions, which cannot be regarded as significant. In the same way the correlation between the number of convictions and the presence or

absence of organic disease is very small (– ·059). To deal adequately with these relationships, we must take into account other factors such as the age at onset of alcoholism, the duration of the alcoholism, etc., but it is at least clear that if the fact that the mentally defective inebriates have more than the average number of convictions be attributed to the direct effect of alcohol and repeated imprisonment on the mental condition of the inebriates, then some reasonable explanation must be found to account for the fact that there is practically the same relationship between the number of convictions and the extent of the education of the inebriates, which is very largely a pre-alcoholic character and that there is *no* relationship with physical condition or with the presence or absence of organic disease.

There is a fairly close relationship (– ·404) between the number of convictions and *delirium tremens*; on comparing the averages we find that those who have had *delirium tremens* have 18 convictions more than those who have not suffered in this way. The relationship with fits is not significant. Those who give trouble in the Reformatory have rather more convictions than those who are well-behaved, and the prostitutes have more convictions than the "moral," even though the prostitutes are nearly 12 years younger than the "moral." There are also substantial relationships with civil status and occupation.

(*e*) *Number of Convictions per Annum.* Instead of dealing with the total number of convictions, we consider here the average annual number of convictions since the onset of alcoholism. These correlations may be regarded as showing the effect of correcting for the influence of the duration of alcoholism the correlation coefficients discussed in the last paragraph. The changes made by this correction are, however, small, the largest being the fall of the correlation with education from – ·270 to – ·190 and the rise in the correlation with morality from – ·309 to – ·357; all the other correlations are of the same order as those with the total number of previous convictions. Here again we see that the correlations with *mental* characters are substantial and those with *physical* characters are very small.

(*f*) *Mental Condition.* It has already been pointed out that the mental condition of the inebriates becomes slightly, but only slightly, worse with age and duration of alcoholism and that there is a fairly close relationship with the total number of convictions and with the average annual number of convictions. The close relationship between mental condition and education is of considerable interest. On the one hand, mental condition is usually regarded as being directly affected by alcoholic excess and on the other hand the extent of an individual's education is very largely determined by causes which are pre-alcoholic; yet we find here that there is a close relationship between the two characters and this is strongly in favour of the view that the defective mental condition of these inebriates, like the extent of their education, is pre-alcoholic and that the alcoholism flows from a pre-existing mental defect, not the mental defect from the alcoholism.

The close relationship between these two characters can be illustrated by arranging the data as in Table XXV.

TABLE XXV. *The Relationship between Mental Condition and Education.*

A.

Mental Condition	Percentage who can read and write well
Good	57·9
Defective	24·4
Very defective	10·3
Insane	5·6

B.

Education	Percentage of good mental condition
Superior	70·6
Can read and write well	58·2
Can read and write imperfectly	25·7
Can neither read nor write	13·4

In Table XXV A, the percentage of inebriates who can read and write well is given for various grades of mental condition; this percentage falls from 57·9 °/₀ among those who are of good mental condition to 5·6 °/₀ among those who become insane while under detention. Similarly in Table XXV B, the percentage of inebriates who are of good mental condition is given for the various classes of extent of education and varies from 70·6 °/₀ among those who have a superior education to 13·4 °/₀ among those who can neither read nor write.

The correlation between mental condition and physical condition is decidedly high (+·348) and that with the presence or absence of organic disease is practically of the same value (+·347). With *delirium tremens*, the relationship is perhaps surprisingly small but that with fits is again high. There is a close relationship (+·460) between mental condition and conduct in the reformatories, and the positive sign indicates that the mentally defective give most trouble. The conduct of those who become insane while under detention presents some interesting features. Altogether 18 inebriates became insane and of these 8 were well-behaved, 3 were manageable, 2 were troublesome and 5 were very troublesome. The distribution of conduct among those who became insane is thus of a distinctly bi-modal form, differing entirely from those of the other grades of mental condition, and suggests that those who become insane are likely to be either very quiet or very troublesome. It would have been of considerable interest to have known the exact form of the insanity in each of those cases, although little stress can be laid on such a small number of cases. The other correlations are small.

(*g*) *Education.* The close relationship between mental condition and the extent of the education of these inebriates has already been considered. The correlations with physical condition and the presence or absence of organic disease are somewhat smaller than the correlations of these characters with mental condition, but they are still significant. The correlation with fits (+·353) is fairly high. There is a positive correlation of ·280 with conduct, indicating that the better educated behave better in the reformatories.

(*h*) *Physical Condition.* Passing over those correlations with physical condition which have already been considered, the first that attracts attention is the very high

correlation with the presence or absence of organic disease. The actual data may be expressed in the following way (Table XXVI):

TABLE XXVI. *The Relationship between Physical Condition and the presence or absence of Organic Disease.*

	No disease	General Debility	Definite organic disease *	Totals
Fit	519	—	52	571
Unfit ...	—	152	142	294
Totals	519	152	194	865

If we take the division as regards disease between "no disease" and "any disease," the ordinary four-fold table method gives as a solution $r = \cdot 998$, which is very nearly equal to unity. We can however divide the table in another way taking as our groups "without definite organic disease" and "with definite organic disease," and in that case we get a correlation of $+\cdot 685$. In whatever way we look at this table it is clear that there is a very close relationship between physical condition and the presence or absence of organic disease.

There is a fairly close relationship with fits and a negative correlation ($-\cdot 189$) with morality which indicates that the immoral are more fit than the moral †. This however is due to the fact that the immoral are very much younger than the moral and this also accounts for the relationship between physical condition and civil status. The other correlations are small.

(*i*) *Organic Disease.* The close relationship between physical condition and the presence or absence of organic disease has already been considered and it is not surprising to find that the correlations involving organic disease are very similar to those involving physical condition. There is naturally a fairly close correlation with age, the older inebriates suffering most from disease, while the correlation of $-\cdot 287$ with the duration of the alcoholism has already been shown to be an indirect effect of age. The positive correlation of $\cdot 347$ with mental condition shows that mental and physical degeneracy go together; this is also illustrated by the fact that those who have had fits are also more subject to organic disease. The correlation with civil status is largely due as before to the indirect effect of age. The other correlations are small.

(*j*) *Delirium tremens.* There is a marked relationship between *delirium tremens* and the total number of previous convictions, the correlation being $-\cdot 404$; those who have had *delirium tremens* have, on the average, 18 convictions more than those who have not had *delirium tremens*, although there is no significant age difference between the two groups. The *delirium tremens* group has also a larger annual number of convictions, started to drink rather earlier and have been drinking

* I.e. cancer, heart-disease, etc.

† See, however, p. 55 below.

rather longer. The relationship with mental condition is small ($+\cdot135 \pm \cdot054$), and in view of the probable error can hardly be regarded as significant. Those who have had *delirium tremens* give rather more trouble than the others in the reformatories.

(*k*) *Fits.* There is a marked correlation between epilepsy and mental condition ($+\cdot323$) and education ($+\cdot353$). Of those who are known to have had fits, only 14 °/₀ are of average mental capacity, while among those not afflicted in this way the percentage rises to 37. This relationship between epilepsy and mental defect is of great importance. Epilepsy cannot be regarded as being caused by alcoholism and further it is certainly inherited; yet we see that it is closely associated with the mental defect of the inebriates, which is commonly assumed to be due to the effects of alcoholism. There is also practically the same relationship with the mental condition and with the extent of education which is very largely determined in childhood. The relationship with physical condition is rather less ($+\cdot249$) but that with the presence or absence of organic disease rises to $+\cdot305$. The other correlations are small.

(*l*) *Conduct.* There is no significant relationship between age and the conduct of the inebriates in the reformatories, but those who behave badly begin to drink at a rather earlier age and of course have been drinking for a rather longer time. All these correlations, small as they are, are considerably reduced when correction is made for morality, because the immoral are rather younger and begin to drink at a rather earlier age than the moral. There is considerable correlation with the total number of previous convictions ($-\cdot213$) and with the average annual number of convictions ($-\cdot243$). Thus those who behave well in the reformatories have an average of 21 previous convictions while those who are classed as very troublesome have an average of 35 previous convictions. The close relationship between conduct and mental condition has already been noted. The immoral behave rather worse than the moral but the other correlations are not significant.

(*m*) *Civil Status and Occupation.* The relationships involving civil status and occupation may most conveniently be considered together. In measuring these relationships we are met at once by the difficulty that here there is no obvious order in which the groups may be taken. For some characters single women and widows fall naturally together and we get single women and widows at the one end of a scale of "closeness to marriage" and married women living with their husbands at the other end. This is the case in dealing with morality or number of convictions. On the other hand, in dealing with age, single women and widows are at the extreme ends of the scale. In such cases, the only available method for measuring relationships is the correlation ratio, η. This presents no difficulty when we are dealing with *quantitative* characters, such as age, or number of convictions, but when we come to consider the relationships between civil status and occupation on the one hand and *qualitative* characters such as mental or physical condition on the other, the correlation ratio can only be calculated when we make some assumption as to the nature of the distribution of the qualitative character, and in the present case these distributions have been assumed to be approximately normal. Whatever objection

may be taken to this, it should be noted that if there be *no* relationship between the characters that are being considered, then the correlation ratio, assuming the divisions to be natural qualitative ones, will be zero while the closest possible relationship will give a correlation ratio of unity. Whatever be the nature of the distribution the correlation ratio thus provides effective measures of the relationships, but the coefficients obtained are only strictly comparable with correlation coefficients when the distributions are approximately Gaussian. In dealing with occupation only three categories are available, and a correlation ratio based on three columns is hardly satisfactory, but the values found are in good agreement with those found from 5 × 3 fold contingency tables (see p. 40).

As I have already stated, I have not attempted to give signs to those coefficients since this is only possible when there is a definite scale-order among the categories. In addition to the list of correlation ratios given in Table XIX, I have given in Table XXVII a statement of the averages and percentages of the various characters in the different groups of civil status and occupation.

TABLE XXVII.

	Character	Civil Status				Occupation			Totals
		Single	Married: living with husband	Married: living apart from husband	Widows	Housewives	Other occupations	No occupation	
Averages	Age	34·4	40·0	39·7	45·4	40·0	40·5	35·5	39·1
	Age at onset	22·6	29·5	27·3	31·5	30·3	27·4	23·8	27·0
	Duration	11·7	10·5	12·4	13·1	9·7	13·0	11·7	12·1
	Convictions	28·4	13·7	24·4	26·7	12·5	25·0	29·9	24·0
	Convictions per annum	2·5	1·3	2·0	2·1	1·3	2·1	2·6	2·1
Percentages	Poor mental condition	67·9	56·2	65·7	63·3	54·4	65·8	67·2	64·0
	Poor education	69·7	70·4	58·7	61·4	65·6	65·5	63·8	65·1
	Unfit for hard work	24·9	32·9	33·9	51·3	30·6	38·7	26·6	34·0
	With organic disease	20·7	36·9	43·7	53·8	34·4	43·9	35·8	40·0
	History of Delirium tremens	9·4	6·8	8·3	5·1	8·7	6·1	10·5	7·7
	History of Fits	3·6	9·1	5·4	2·5	8·1	4·6	3·5	5·0
	Bad conduct	33·9	24·4	34·3	27·9	24·4	32·6	32·2	31·0
	Immoral	79·1	5·1	55·1	50·0	8·1	49·2	87·3	51·7
	Regular drinkers	72·2	63·6	63·8	64·6	64·4	64·1	73·4	66·6

Dealing first of all with civil status we find that the correlation ratio measuring the relationship between age and civil status is ·379. This is fairly large and indicates a marked departure from independence. If we turn to Table XXVII, we find as might be expected that the unmarried inebriates are on the average more

than 5 years younger than the married inebriates and 11 years younger than the widows. There is little difference between the married women who are living with their husbands and those who are living apart from their husbands. The relationship between civil status and the age at onset of alcoholism is also fairly close, but some caution must be used in interpreting this relationship since the civil status is that noted *on admission* while the age at onset refers to a period on the average 12 years before this. Table XXVII shows however that those who were single on admission started to drink 9 years earlier than those who were widows on admission. The relationship between civil status and the total number of previous convictions shows that single women have the highest number of convictions and married women living with their husbands the lowest number. In mental condition and education the differences are small, but in view of the high correlation between age and civil status it is not surprising to find that the relationships with physical condition and the presence or absence of organic disease are larger. Thus only 24·9 °/₀ of the single women are unfit for hard work while 51·3 °/₀ of the widows are unfit for hard work; again only 20·7 °/₀ of the single women have organic disease as compared with 53·8 °/₀ among the widows. The only other relationship on which stress can be laid is that between civil status and morality. The correlation ratio in this case is ·656. If we turn to the Table of Averages and Percentages we find that 5 °/₀ of the married women living with their husbands are prostitutes, 50 °/₀ of the widows, 55 °/₀ of the married women living apart from their husbands and no less than 79 °/₀ of the single women.

If we now consider the relationship between civil status and morality, we shall find the explanation of the differences between the relationships of the various characters with civil status and those with occupation. The only available method of measuring the relationship between civil status and occupation is that of the contingency coefficient, and its value in this case is ·621, showing a marked divergence from independent probability. The term "housewife" is reserved for those who are performing ordinary household duties, and in the class from which these inebriates are drawn is never applied to single women or widows and rarely to married women living apart from their husbands; out of 160 housewives, 137 are married women living with their husbands and 23 are married women living apart from their husbands, usually on separation allowances. On the other hand those who are classed as having "no occupation" are usually single women or married women living apart from their husbands.

The correlations of the various characters with occupation are, as a rule, rather less than with civil status. There are still however substantial relationships with the total number of convictions and with the average annual number of convictions. Women of no occupation have more than twice as many convictions as housewives. The most striking relationship is that with morality. The correlation ratio in this case is ·643 and we find that while 8·1 °/₀ of the housewives are classed as "immoral," 49·2 °/₀ of women with "other occupations" and 87·3 °/₀ of women with "no occupation" are classed as immoral. It is clear that we must realise that prostitution is a definite

occupation of the women of the class with which we are dealing, and it might have been better to have dealt with prostitutes as an occupational group and classified the inebriates according to the degree of their economic dependence on prostitution, but the particulars given are hardly sufficient for this purpose.

(*n*) *Morality*. With one exception all the correlations involving morality have already been considered but it is desirable to deal with them again as a whole. The correlation between morality and age on admission (+·410) is very marked, the inebriates who are classed as "immoral" being much younger than those who are classed as "moral." Further, the immoral begin to drink at a much earlier age than the moral, while the duration of alcoholism is practically the same in the two classes. The negative correlations with the total number of convictions (−·309) and with the average annual number of convictions (−·357) show that the immoral have more convictions and a larger annual number of convictions than the moral, although the duration of alcoholism is nearly the same in the two groups. As regards mental condition there is practically no difference between the two classes, but the physical condition of the immoral is distinctly better than that of the moral. 40 °/ₒ of the moral are unfit for hard work and only 29 °/ₒ of the immoral, but this arises solely from the fact that the immoral are much younger than the moral. The direct correlation between physique and morality is −·189 but if this be corrected for age it is reduced to +·001, showing that when age is taken into account there is no difference between the moral and immoral as far as physique is concerned. The correlation ratios with civil status and occupation are high, indicating that there are marked differences in the proportions of prostitutes in the different groups.

(*o*) *Regular or Periodical Drinking*. Considerable doubt has already been expressed as to the value of the classification of the inebriates into regular and periodical drinkers, and a study of the correlations shows that there is no marked difference between the two classes for any of the characters considered here. Some of the correlations are significant with regard to their probable errors but the absolute values are in every case small, the largest being that between morality and regular or periodical drinking (−·169), which indicates that the immoral are more often regular drinkers than the moral, the percentages being 71 and 61 respectively.

VII. *The Relationships between the Intensity of Alcoholism and the Mental and Physical Characteristics of the Inebriates.*

In the "Preliminary Study of Extreme Alcoholism" the influence of the intensity of alcoholism on the mental and physical condition of the inebriates was investigated in two ways. In the first place the total number of previous convictions was taken as a measure of the intensity of alcoholism. Such a method, however, takes no account of the length of the period during which the convictions took place and it might be suggested that the like number of convictions spread over a large number of years will not measure the same alcoholic tendency as if they were concentrated into a few years. No estimate of the actual duration of the alcoholism was, however, available but, since the youngest inebriate was aged 16, it was thought

that the total number of convictions divided by the excess of years of the individual over 16 would give some measure of the intensity of the alcoholism. Such a measure gives the average annual number of convictions on the assumption that all the inebriates began to drink at the age of 16; and as we have seen from the present data the average age of onset is 27 years, but 50 °/ₒ of the inebriates begin to drink under the age of 24 and the age group at which the largest number of women begin to drink is from 16 to 19 years. In the present investigation the age at onset of alcoholism, the duration of the alcoholism and the age on admission are all given although the age at first conviction is not given. The average annual number of convictions from the onset of alcoholism until admission to a reformatory furnished therefore a rather better estimate of the intensity of alcoholism, although it would have been still more satisfactory to have taken the period from the date of first conviction. It should at once be stated, however, that the results obtained by taking the average annual number of convictions since the onset of alcoholism differ little from those obtained on the assumption that all the inebriates began to drink at the age of 16.

It is possible, however, to obtain other measures of the intensity of alcoholism by making use of partial correlation coefficients. The partial correlation coefficient between the total number of convictions and the mental condition for a constant duration of alcoholism is practically the same as the correlation between the average annual number of convictions and the mental condition. Further, since it is possible that the age at onset of alcoholism may be of importance, this can be made constant also and thus its effect eliminated. There are thus six methods altogether of dealing with the intensity of alcoholism; we can, for instance, take the correlation between mental condition and the total number of previous convictions (*a*) direct, (*b*) with age constant, (*c*) with duration of alcoholism constant, (*d*) with age at onset of alcoholism constant or between mental condition and the average annual number of convictions, (*e*) direct, (*f*) with age at onset of alcoholism constant.

Now in dealing with mental characters in addition to mental capacity of the inebriates, I have included the extent of their education on the ground that it is very largely determined by their mental condition at school age and is therefore pre-alcoholic. The physical characters considered are the general physical condition, judged by their fitness for hard work in the reformatories, and the presence or absence of organic disease. The correlations are as follows:

TABLE XXVIII.

(*a*) *Correlations with Total Number of Convictions.*

Mental characters	Correlations
Mental condition ...	$-\cdot352 \pm \cdot020$
Education	$-\cdot270 \pm \cdot021$

Physical characters	Correlations
Physical condition	$-\cdot043 \pm \cdot023$
Organic disease......	$-\cdot059 \pm \cdot023$

(*b*) *Correlations with Total Number of Convictions* (*Age Constant*).

Mental characters	Correlations
Mental condition ...	$-\cdot339 \pm \cdot020$
Education	$-\cdot250 \pm \cdot021$

Physical characters	Correlations
Physical condition	$+\cdot040 \pm \cdot023$
Organic disease......	$+\cdot001 \pm \cdot023$

(*c*) *Correlations with Total Number of Convictions* (*Duration of Alcoholism Constant*).

Mental characters	Correlations
Mental condition ...	$-\cdot309 \pm \cdot021$
Education	$-\cdot211 \pm \cdot022$

Physical characters	Correlations
Physical condition	$+\cdot061 \pm \cdot023$
Organic disease......	$+\cdot014 \pm \cdot023$

(*d*) *Correlations with Total Number of Convictions* (*Age at Onset of Alcoholism and Duration of Alcoholism both constant*).

Mental characters	Correlations
Mental condition ...	$-\cdot317 \pm \cdot021$
Education	$-\cdot210 \pm \cdot022$

Physical characters	Correlations
Physical condition	$+\cdot027 \pm \cdot023$
Organic disease......	$-\cdot016 \pm \cdot023$

(*e*) *Correlations with Average Annual Number of Convictions.*

Mental characters	Correlations
Mental condition ...	$-\cdot336 \pm \cdot020$
Education	$-\cdot190 \pm \cdot022$

Physical characters	Correlations
Physical condition	$+\cdot050 \pm \cdot023$
Organic disease......	$+\cdot058 \pm \cdot023$

(*f*) *Correlations with Average Annual Number of Convictions* (*Age at Onset of Alcoholism Constant*).

Mental characters	Correlations
Mental condition ...	$-\cdot340 \pm \cdot020$
Education	$-\cdot185 \pm \cdot022$

Physical characters	Correlations
Physical condition	$+\cdot017 \pm \cdot023$
Organic disease......	$+\cdot032 \pm \cdot023$

Now whatever method be selected for measuring the intensity of alcoholism, we obtain the same result, that there is a distinct relationship between *mental* characters and the intensity of alcoholism, that the relationship between the intensity of alcoholism and a pre-alcoholic character such as education, though rather less than that with the mental condition of the inebriates, which is generally

supposed to be directly affected by the alcoholism, is still significant, and that there are no sensible relationships with physical characters. Judged by any of these tests, the mentally defective and those with poor education show a considerably greater intensity of alcoholism than those of average mental capacity.

This result can be illustrated by a method similar to that already used in dealing with the relationships between age, duration of alcoholism, and physique. If we look at the correlation table giving the relationship between age at onset of alcoholism and duration of alcoholism (Appendix, Table 12), we see that all the women entered in the same *column*, within narrow limits, started to drink at the same age, while all those entered in the same *row* have in the same way the same duration of alcoholism. All those entered in the same compartment have thus the same age at onset of alcoholism and the same duration of alcoholism. It is thus possible to obtain, for a number of groups, the average number of convictions of those of average mental capacity and of the mentally defective, of those who are fit for hard work and of those who are unfit for hard work.

In 25 groups there are sufficient numbers to form an average and we find that in 24 groups the mentally defective have more convictions than those of average mental capacity, while in only one group is the reverse the case. When we deal with physique on the other hand, we find that in 12 groups the fit have more convictions than the unfit, while in 13 groups the unfit have more convictions than the fit and that in all 25 groups the differences are small. Taking as before the averages of the differences we find that while the mentally defective have, for constant age at onset and constant duration of alcoholism, 11·7 convictions more than those of average mental condition, the physically fit had 0·2 convictions more than those unfit for hard work. These differences correspond to partial correlations of $-·317$ and $+·027$ respectively.

What meaning are we to attach to these results? If the close relationship between the intensity of alcoholism and the mental condition of the inebriates be regarded as causal, if the mental defect be looked upon as the direct result of the alcoholism, then some explanation must be found for the fact that the alcoholism has no apparent effect on their fitness for hard work and for the high relationship between the extent of the education of the inebriates, which is very largely determined by their mental condition while of school age and is therefore pre-alcoholic, and their mental condition while in the reformatories after many years of drunkenness.

The problem is a difficult one and can only be solved completely when we have the whole histories of these women from school age. The expenditure of a few hundred pounds in tracing back the school records of the younger women who are at present in the reformatories would go far to solve the problem, but the complete solution is only to be found in following through life *every* mentally defective child. The present data certainly support the view that the mental defect to a very large extent precedes the alcoholism and that this pre-existing mental defect is only slightly increased by the alcoholism.

VIII. *The Results of Reformatory Treatment.*

(i) *The Reform of the Inebriate.* The present system of reformatory treatment of inebriates was initiated in 1899. Up to the end of 1909, 3309 inebriates had been admitted and 2293 discharged. It is not unreasonable then to ask for some account of the results of reformatory treatment so far as the reform of the inebriates is concerned.

The official views as to the purposes for which these reformatories were established and the results to be expected from them are quite clear. In the General Regulations for the Management of Inebriate Reformatories* it is laid down that "Discharge on licence should be possible after 9 months treatment and should be the usual practice at the end of 12 months. If the inmate is not licensed at the end of a year, the matter should be reported to the Secretary of State." Notwithstanding this regulation, licensing is very little used. Out of 973 inebriates whose sentences had not expired at the end of 1909, only 27 were out on licence although the usual sentence is one of three years detention, and thus most of the inebriates remained in the reformatories two years after the time when it was thought they ought to be discharged. Further particulars of the extent to which the licensing system has been used are to be found in Dr Branthwaite's Report for 1908 †. Up to the end of 1908, 670 licences in all were issued while 3032 inebriates had been admitted to reformatories. If we deduct from this total the 262 inebriates who were admitted in 1908, we find that 2770 inebriates had been under treatment for at least a year and therefore ought to have been licensed and only 670 licences were actually issued, and of this number 247 were subsequently revoked. Much greater care has been taken in later years in the issuing of licences. Up to 1905, 48 °/ₒ of the licences issued were subsequently revoked, while during the three years 1906—1908, only 16 °/ₒ of the licences were revoked. These licences are also issued at a much later stage in the sentence than was originally thought desirable. 73 °/ₒ of the sentences to reformatory detention are for a period of three years and the average length of sentence is rather more than 2½ years. If inebriates were licensed at the end of a year, the average duration of *licence* would be 1½ years. Actually it is less than 8 months. It is thus clear that, in the opinion of the medical officers of these reformatories, only a small proportion of the inebriates are fit for discharge at any time before the expiry of their sentences. Yet discharged they must be. It must also be remembered that the inadequacy of the accommodation for inebriates cannot fail to have some effect on the licensing system and it is probable that many inebriates are discharged too soon in order to make room for others and that breaches of licence are apt to be overlooked.

This point is put even more forcibly by Sir H. B. Donkin, Medical Adviser to the Prison Commissioners, who served on the Departmental Committee which drew up the Model Regulations for the Management of Inebriate Reformatories and also

* Reg. No. 69. See Dr Branthwaite's Report for 1906, p. 56.
† p. 14.

on the recent Committee on the working of the Inebriat[illegible] A[illegible]gue opi[illegible]discussing the report of the former Committee he says: "Their report [illegible] Comm[illegible]at the whole scheme of treatment of inmates should be based on [illegible]e p[illegible]sed. [illegible]e [illegible]hat they are detained for reformation not for punishment. 'Towards tl[illegible] by no [illegible]iple[illegible] should be directed the dietary, the discipline, the recreation, the moral [illegible]orities [illegible]gious training, and even the forced labour.'...Great emphasis was laid on lic[illegible]rmation [illegible] temporary leave of absence: first under escort and then on parole. Th[illegible] [illegible]ve "reform [illegible]ere of opinion that this would be the only practical test of the sche[illegible] [illegible]d the term[illegible] [illegible]ere of opinion from the weight of the evidence given, which was una[illegible] [illegible]re said [illegible]at the majority of the inmates who were not fit for licence at the end of [illegible] wo[illegible]l not benefit at all by longer detention*." A similar opinion was expressed by the Prison Commissioners in submitting draft regulations.

In commenting on the working of the Inebriates Acts, Sir H. B. Donkin says: "The fact that licensing has largely fallen into desuetude is proof that the whole Act as at present worked is a complete failure from the point of view of its promoters, i.e., as far as reform of the individual inebriates treated is concerned. Experience of the three years' sentence to inebriate reformatories shows that detention of this length has been useless, most inmates being now discharged as practically hopeless cases without having been licensed or tested in any way, and many having been re-committed already. The fact, as has been shown by experience, that considerable numbers of the inebriates committed under the Acts are insane or otherwise mentally defective, points to the necessity of dealing with this class of inebriate as mentally defective and of controlling them effectively and indefinitely†."

This view may be said to be general and it is of no small significance to find that the Inspectors under the Inebriates Acts for England and for Scotland both object to the use of the very word "Reformatory." Thus Dr Branthwaite says: "It is proving extremely unfortunate that the word Reformatory was ever selected to apply to Institutions for the reception of committed inebriates" and again that "many committals are in the lowest possible state of unimprovable degradation. It has become necessary to set apart some of our institutions as little better than moral refuse heaps for the detention of the hopelessly defective at the lowest possible cost to the country‡."

Dr Dunlop, the Inspector under the Inebriates Acts for Scotland, in his evidence before the Scottish Departmental Committee§ is equally emphatic and said: "The word Reformatory is a misnomer and gives a false conception of the situation" and again "I have already expressed the opinion, and I adhere to it, that the word Reformatory is a myth. It is a place for seclusion. It is more of the nature of an asylum or place of refuge than a Reformatory."

* Minutes of Evidence (English Committee), p. 187.

† *Ibid.*, p. 188.

‡ Reports of the Inspector under the Inebriates Acts, 1906, p. 15, and 1905, p. 9.

§ Departmental Committee on the Inebriates Acts (Scotland). Minutes of Evidence, pp. 1 and 14.

I have tr: briate Rec information regarding the results of reformatory treatment of ineb 13 women a he available official sources but it is decidedly unfortunate that we have n; which the cord of *every* inebriate after discharge*. For the most part the infor that t was able to obtain was derived from the replies made by various author 59 are the question: "In regard to all police court or criminal inebriates 15 th tually committed or only qualified for committal to a reformato se in whic age do you consider likely to relapse into drinking habits after having influence sentence under the Inebriates Acts?" This question was one of a seri eglectful estions which were drawn up and circulated by the Departmental Com way of e Inebriates Acts in England and was answered by 31 out of 45 witnesses. The form of the question is decidedly unfortunate. At the time the Departmental Committee was sitting, 1524 inebriates had been discharged from inebriate reformatories. Now the police or other court from which each inebriate was committed is of course known and it would have been a comparatively simple matter to circularise the police authorities of every district from which an inebriate was committed. Of the inebriates a certain number would have disappeared, but the proportion of cases who could not be traced by the police authorities would have been much smaller than the proportion lost sight of by the authorities of the inebriate reformatories. We find for instance, if we sum the experience of all the police authorities who answered this question, that only 16 out of 251 could not be traced. In Scotland out of a total number of 181 inebriates, only 9 could not be traced after discharge. Had this procedure been adopted, a definite statement regarding the behaviour after discharge of between 80 °/ₒ and 90 °/ₒ of all inebriates would have been obtained. On other grounds it is essential that every sentence of reformatory detention should conclude with a period of licence or probation, and were this system adopted we should have a record of the behaviour after discharge of *every* inebriate. Unfortunately the Departmental Committee, instead of asking for the production of all the available evidence regarding the behaviour of the inebriates after discharge, were content to accept mere opinions and hence in comparatively few cases were the answers of real value. It is of little use to be told that the percentage of inebriates *likely* to relapse is "a large proportion," "all of them," "probably 75 °/ₒ," "at least 90 °/ₒ" unless we can examine the facts on which these vague opinions are presumably based; nor does it help to be told that a witness cannot give any percentage but that so far as regards the State Institution at Ennis, the Irish Prison

* In this connection a splendid opportunity was missed by the recent Departmental Committees on the Inebriates Acts. Instead of demanding *all* the available information on the results of reformatory treatment, they were content with statements of the vaguest kind and in some cases the form of the questions put directly invited such vague opinions. Thus the English Committee circulated the following question to 45 authorities:—In regard to all police court or criminal inebriates who have come under your notice whether actually committed or only qualified for committal to a reformatory, what percentage do you consider likely to relapse into drinking habits after having served a full sentence under the Inebriates Acts? (Question 24, Minutes of Evidence, p. 122). Some day even Departmental Committees will realise that social problems cannot be solved by opinions merely but only by statistical facts.

Board consider their results satisfactory. Instead of asking vague opinions regarding the percentage of inebriates *likely* to relapse after discharge, the Committee ought to have asked for the numbers of inebriates who actually *had* relapsed.

Even in cases where numbers are given, the records are by no means uniform and often very indefinite categories are used. By some authorities inebriates are said to be "doing well" or "not doing well" without any information as to what those terms really mean. In other cases inebriates are said to have "reformed" but again no information is given as to what constitutes "reform," and the term seems to be used in rather an elastic fashion; in some cases those who are said to have "reformed" are also said to have been convicted after discharge. I shall give however the experience of every authority who has given figures.

(*a*) The Rev. Canon C. J. Parker*, Representative of the Managers of the Brentry Certified Inebriate Reformatory, has given the experience of that institution. His statement is as follows:—"Our experience at Brentry is that out of the 227 discharged between Jan. 1904 and May 1908, 144 of whom have been kept under observation, 75 at least are still doing well." No information is given regarding the time the inebriates were under observation after discharge, but this cannot be greater than 4½ years and may be only a few weeks. It is absolutely essential that the actual time that each inebriate was under observation after discharge should be stated. Canon Parker states here that only 227 inebriates were discharged between Jan. 1904 and May 1908, but from the figures given in Dr Branthwaite's Report for 1909 (p. 99), it would seem that the actual number discharged was considerably greater than this. We find that 474 inebriates were admitted to Brentry during the years 1901—4 inclusive and, if each served a sentence of three years detention, would be discharged during the years 1904—7 inclusive. Now some of those committed in 1901 and 1902 for shorter periods than three years would be discharged *before* the beginning of 1901 and so would not be included in the years 1901—4, but on the other hand some inebriates committed during 1905 and 1906 would, in similar circumstances, be discharged during 1901—4, so that these factors will neutralise each other and as in addition some must have been discharged during the first five months of 1908, we may be fairly certain that at least 474 inebriates were discharged during the period in question instead of the 227 given by Canon Parker. Apart from this, however, any statement of the results obtained in this reformatory ought to have been based on the *whole* experience of the institution, on the after histories of nearly 600 inebriates who had been discharged before the return was made. It should be noted that 83 of the 227, more than one-third, were lost sight of and that the sexes are not distinguished, although 41 °/o of the inebriates admitted to this reformatory are males.

(*b*) In a Memorandum presented to the English Departmental Committee, Mr Robert J. Parr †, Director of the National Society for the Prevention of Cruelty to Children, gives the experience of that Society in dealing with women committed

* Minutes of Evidence (English Committee), p. 124.

† *Ibid.*, p. 201.

to Certified Inebriate Reformatories under Section I of the Act. Mr Parr gives the records of 133 women committed between April 1, 1902 and March 31, 1904, but the time during which they were under observation is not stated. Here again it is unfortunate that the whole experience of the Society is not given. Of these 133 inebriates, 59 are said to have reformed, 54 to have relapsed, 5 died or became insane and of 15 there is no record. Thus 44 °/₀ are said to have reformed but the exact sense in which the term is used is not stated. The attitude of the husband and his influence on the inebriate are also given. In 25 cases the husband was hostile to or neglectful of his wife during detention; in 12 cases the husband placed obstacles in the way of her return; and in 22 cases the conduct of the husband was a hindrance to the wife after her return. Assuming that no man appears more than once, we find that the home conditions were unfavourable to these women in 44 °/₀ of these cases. Among the general body of inebriates only 20 °/₀ were married women living with their husbands before committal, and if we assume that the same proportion of husbands were hostile to, or had a bad influence over, their wives we see that among Mr Parr's cases 56 °/₀ returned to comparatively favourable home conditions while among the general body of inebriates this percentage is only 9 °/₀. Further it has already been pointed out that the condition of women on committal, under the two Sections of the Act, differs widely. The working of Section I of the Act has been allowed to fall almost entirely into the hands of this Society and the women committed are younger, have fewer previous convictions and include few prostitutes*. Just as good results seem to be obtained from married women living with their husbands before committal who are committed under Section II of the Act. The fact that such inebriates are living with their husbands is evidence that they are of a higher standard than the general body of inebriates, and on this account, in conjunction with the vastly greater prospects of care and restraint after release, it is only reasonable that better results should be obtained.

(*c*) The third series is also given in somewhat indefinite terms. Mr Leonard Dunning, Head Constable for Liverpool, gives the experience of that town and his statement is as follows†:—"Our actual record of relapses is 56½ °/₀ out of a total number of 60 (8 males, 4 relapses; 52 females, 34 relapses) released after detention." The actual percentage of relapses is however 63·3 °/₀ and not 56½ °/₀. No information is given as to the time the inebriates were under observation after discharge nor any definition of "relapse," so that further analysis is impossible.

(*d*) Mr C. M. Atkinson‡, Stipendiary Magistrate for the City of Leeds, has given the experience of that city as follows:—"Twenty-eight persons committed from Leeds, since the beginning of the year 1903, have been released. The following reports have been made, lately, concerning them:—

* Dr Branthwaite in describing these cases (Report for 1908, p. 16) says that these cases are "the best of all those sent to detention under the Inebriates Act of 1898; they are, for the most part, decent individuals with homes to go back to, and the majority are persons who have not been subjected to many short sentences of imprisonment before the application of suitable treatment has been resorted to."

† Minutes of Evidence (English Committee), p. 123.

‡ *Ibid.*, p. 122.

Subsequently convicted of public drunkenness ...	9 (some of them many times)
Doing well	8
No reports	8 (some have disappeared)
Convicted of felony and sent to penal servitude ...	1
Leading a bad life	1
Dead	1"

Out of 28 inebriates, 8 are thus said to be doing well, but again the period of observation is not stated and it cannot average more than a year. The sex of these inebriates is not stated.

(*e*) Mr J. G. H. Halkett*, Stipendiary Magistrate at Hull, gives in considerable detail the histories after discharge of 23 inebriates committed from Hull. Of the 23, 8 are men and 15 women. The first case is that of a man, aged 37, who after being 18 months in Brentry Inebriate Reformatory was discharged on licence, got drunk immediately on arrival at Hull and was sent back to the reformatory. After completing his period of detention, he returned to Hull and has been convicted of drunkenness 11 times within three years, a large part of which however has been spent in prison as he has been sentenced to terms of imprisonment for these offences of 30 days and sureties, or one, two, or three months' alternative imprisonment added. He is said to be "hopeless." The second case, a man aged 62, has been convicted of drunkenness 15 times since discharge, of larceny caused by drink, once, and using obscene language while under the influence of drink, once; nevertheless Mr Halkett thinks that "he would have been much worse than he is" but for his three years' reformatory detention. The third case, a man aged 35, has, since his release, been convicted 18 times of which 14 convictions are for drunkenness. Thirteen others have been convicted in all 64 times of which all but 27 are for drunkenness. Of those who have not been subsequently convicted, two could not be traced, one, after a year's freedom, has been committed for trial for felony. "He has, notwithstanding this, apparently been a sober man since he came out of the reformatory." Of the four remaining, one is "doing well," one is "apparently going on all right" and two are "as far as is known," keeping clear of drink. These four are much younger than the others, their ages being 26, 19, 33 and 40. Out of 23 inebriates, 4 are thus thought to be doing well.

(*f*) Mr J. B. Wright†, B.A., LL.D., Chief Constable, Newcastle-upon-Tyne, gives particulars of 61 persons who have been sent to inebriate homes from Newcastle-upon-Tyne. Of these there have been:—

Convicted of drunkenness since return ...	34
Convicted of other offences	2
Re-committed	1
In Asylums	2
Dead	1
Whereabouts unknown	6
Doing well since return	4
At present in inebriate homes	11
Total	61

* Minutes of Evidence (English Committee), p. 113.
† *Ibid.*, p. 125.

"Five of those shown as convicted of drunkenness since their return from the homes have only one conviction against them but three of these only returned twelve months ago."

Out of 50 who have been discharged only 4 are said to be doing well.

(*g*) A Memorandum submitted by Mr G. Nelson*, Police Court Missionary at Marlborough St. Police Court, gives information regarding 140 inebriates committed from that police court and 3 other inebriates committed from other courts and subsequently convicted of drunkenness at Marlborough St. Out of these 143 cases, however, 69 had not been discharged from the reformatories leaving 74 who had been discharged. The time that elapsed between the expiry of sentence and the date of the return in those cases was as follows:—6 years, 1 case (twice re-committed to a reformatory after discharge); 5 years, 1 case; 4 years, 3 cases of whom 1 was re-committed; 3 years, 8 cases of whom 5 were re-committed; 2 years, 9 cases of whom 1 was re-committed; 1 year, 11 cases of whom 3 were re-committed; less than a year, 41 cases of whom 1 was re-committed after discharge. The 12 cases who were re-committed after discharge have thus been at liberty for a much shorter time than those figures indicate†.

Dealing first of all with the 33 inebriates who had been at liberty for at least a year, we find that 1 inebriate was after discharge re-committed to a reformatory on two occasions, 10 inebriates were re-committed for the second time, 13 were convicted of drunkenness at Marlborough St., 51 times of drunkenness and 27 times of other offences while 9 inebriates were not convicted at Marlborough St. after discharge. Now to be committed to an Inebriate Reformatory under Section II of the Act (under which the great majority of the inebriates are committed) four convictions for drunkenness within the year must be proved, no account being taken of convictions for other offences. These 11 inebriates who were re-committed to reformatories, besides having their opportunities for being convicted considerably reduced, must thus have been convicted 48 times of drunkenness, so that out of 33 inebriates 24 were convicted 126 times of which 99 convictions were for drunkenness and 27 were for other offences. The average time during which they were at liberty must be considerably less than two years.

Of the 41 inebriates who had been at liberty for less than a year, some only for a few days, 1 was re-committed to a reformatory, 16 were convicted at Marlborough St. of drunkenness 26 times in addition to 10 times of other offences, while 24 were not convicted of drunkenness at Marlborough St. after discharge. Out of 74 inebriates who were at liberty for an average of little over a year, 12 were re-committed to reformatories, 29 were convicted of drunkenness at Marlborough St., 41 inebriates being convicted at least 166 times while 33 were not convicted at Marlborough St.

The experience of Marlborough St. Police Court is given in slightly different

* Minutes of Evidence (English Committee), p. 195.

† One woman spent "7 years out of the 9, at the expense of the country, in a home."

form by Mr Ernest Baggallay, one of the Metropolitan Police Magistrates* who deals with 66 inebriates who had been committed from Marlborough St. "Of those 66, 44 have been convicted again of drink offences; and of those 44, 10 have been sent again to homes." Mr Baggallay also gives the experience of Tower Bridge Police Court. Out of 80 inebriates who had been released, "38 have been convicted of drink offences since, and 16 out of the 38 have been sent a second time to homes."

(*h*) Mr Wm Barradaile†, Clerk to the Magistrates, Birmingham, gives particulars of 45 inebriates committed from Birmingham. The records, however, refer to convictions in Birmingham only. Mr Barradaile says: "I send you a return of all the cases sent, with the record of their convictions subsequent to their discharge according to our court registers. I have no means of showing the convictions in other courts, nor can I furnish any report as to their conduct apart from our records." The return is not dated, but from internal evidence seems to have been made up at the end of June 1908 (the Report of the Committee is dated Dec. 1908). Particulars are given of 45 inebriates, but 3 are entered in duplicate, having been committed to reformatories for a second time, 16 had not completed their sentences while 5 had only been at liberty for periods ranging from a few days to 4 months. We have thus 21 cases available for analysis. These inebriates have been at liberty for from one to six years after discharge and I have set out their histories after discharge as follows:—

TABLE XXIX.

No.	Subsequent convictions	No.	Subsequent convictions	No.	Subsequent convictions
1	Nil	8	11‡	15	Nil
2	11	9	6	16	2
3	19‡	10	7	17	1
4	16‡	11	Nil	18	Nil
5	Nil	12	Nil	19	1
6	Nil	13	7	20	3
7	2	14	1	21	Nil

Thus of the 21 inebriates, 8 were not convicted in Birmingham after discharge, the remaining 13 were convicted 87 times and of these 3 were re-committed to reformatories.

(*i*) Particulars regarding 352 inebriates are given by Sir Wm Vincent, Bart., J.P., Representative of the Inebriates Reformation and After-Care Association§, but fuller details regarding 407 cases dealt with by this Association are given in

* Minutes of Evidence (English Committee), p. 29.

† *Ibid.*, p. 125.

‡ Re-committed to reformatory.

§ Minutes of Evidence (English Committee), p. 125.

Dr Branthwaite's Report for 1908*. "The officers of this society have taken in hand all inmates discharged from reformatories who, before discharge, consented to avail themselves of proffered help. No selection of cases has been made; good and bad alike have been handed over to the care of the society. Bearing in mind our previous remarks on the mental state of inmates, the known dislike to disciplinary control which is characteristic of the class, and the difficulties met with in the attempt to direct the lives of such persons by moral influence, it is not surprising that many have relapsed as soon as they were free from physical control, and that more still have been lost sight of. The following is a summary of reports on 117 men and 290 women, 407 cases in all, befriended by the Inebriates After-Care Association between 17th March, 1903 and 12th November, 1908. Some of these cases were released on licence before expiry of sentence; but the majority were discharged from all control because, notwithstanding their unfitness for liberty, no legal power exists to detain them longer.

TABLE XXX.

	Men	Women	Men	Women	Totals
With satisfactory result			32	50	82
Result not known:—			49	162	211
Declined help	23	56			
Emigrated	2	4			
No reports received	9	15			
Cases discharged more than three years and who are no longer to be found	15	87			
Unsatisfactory:—			36	78	114
Relapsed into drunkenness at once	25	52			
Returned to reformatories	5	12			
Sent to lunatic asylums	—	3			
Sent to other institutions	3	5			
Died	3	6			
Totals			117	290	407

"Taking all cases together, these figures indicate (1) that 52 per cent. of cases were lost sight of after discharge from reformatories, the ultimate result of detention being unknown; (2) that 28 per cent. relapsed into drunkenness soon after release; and (3) that 20 per cent. became, and remained†, sober and decent members of the community."

* p. 14.

† Some of the inebriates however had not been at liberty long enough to test adequately the permanence of reform.

(*j*) Sir G. L. Gomme*, Clerk to the London County Council, has given particulars of 394 inebriates discharged from Farmfield Inebriate Reformatory. His statement is as follows:—"Out of 394 patients discharged from Farmfield only 56 are known to be doing well which is approximately 15† per cent.; 197 relapsed, the majority almost immediately; 53 mentally deficient, unmanageable or conduct unsatisfactory and transferred to State or other reformatory; 15 physically unfit to benefit from treatment; 7 certified to be insane; 8 died; and 58, no reliable information as to, or lost sight of." It should be noted that this reformatory is reserved for female inebriates selected as likely to be amenable to, and benefited by, reformatory treatment. No criminal cases are admitted. The care with which inebriates are selected for admission to Farmfield is shown by the fact that only 15 °/₀ are mentally defective while among female inebriates in general the percentage is 64. This selection of cases is due to a system of classifying reformatories which is described fully in Dr Branthwaite's Report for 1906 (p. 18), and the extent to which it is used is shown by the fact that in 1906, "301 persons were changed from one of these institutions to another, solely for the purpose of classification, to remove the good from the bad, and so give the former every possible chance of benefit." With all these advantages, however, only 14 °/₀ are said to be doing well; the time during which the inebriates were under observation is not stated.

(*k*) Dr F. A. Gill, Resident Medical Superintendent of the Lancashire Certified Inebriate Reformatory at Langho, in reply to the question asked by the Departmental Committee, stated that the percentage of inebriates likely to relapse into drinking habits was "seventy to eighty per cent., but the percentage is solely dependent upon the feeble-minded and old prison recidivists‡." In his Annual Report for 1910, however, he gives (p. 5) a report on all women who had passed through and left this reformatory prior to August, 1910; and his figures do not include any woman who has been less than six months at liberty. His statement is as follows:—

TABLE XXXI.

Total No. discharged	Doing well	Much improved	Improved	Relapsed	Dead	Senile dements, Imbeciles, Insane, Quasi-insane, Transferred to State Reformatory	Not traceable, No Reports
227§	34	17	15	88	13	50	10

The information "is based in all cases on the report of the Chief of Police of the authority from which they were committed," although in some cases where the police

* Minutes of Evidence (English Committee), p. 123.

† Actually it is 14·2 °/₀.

‡ Minutes of Evidence (English Committee), p. 123.

§ Eight re-committed and discharged twice are counted as one discharge each.

were unable to furnish a report, information from other sources has been used. Of the 51 who are doing well or are much improved, 13 have been at liberty for over 3 years, 12 from 2 to 3 years, 14 from 1 to 2 years, and 12 from 6 months to a year. No statement is made regarding the length of time the other inebriates have been at liberty. Of those who are said to be "doing well," some had relapsed once after discharge but had subsequently kept sober. Thus 34 out of 227 inebriates, 15 %, are said to be doing well while an additional 7·5 % are said to be much improved.

In considering these results, however, Dr Gill confines his attention to 109 "possibly reformable cases." He deducts the inebriates who died, 13 in all, 50 who were insane or imbecile, 23 women who had more than 50 previous convictions, 29 women who were at least 50 years of age and 3 who were "unable to earn their own livelihood by reason of bodily ill-health," 118 in all. From the point of view of the medical officer in charge of a reformatory, this is perfectly justifiable as there is no doubt that a large number of hopeless cases are at present admitted to the reformatories, and his policy is clearly to consider only those he holds likely to reform; but in estimating the results of the whole system of reformatory treatment the outside critic must include every case admitted to a reformatory. In the first place Dr Gill himself states in his Report for 1910 (p. 8) that one woman is doing well after 3½ years' liberty notwithstanding 59 previous convictions and that another is "much improved" after 20 months' liberty although she had 69 previous convictions. Further it will be remembered that the "Preliminary Study of Extreme Alcoholism" was based on Dr Gill's data, which gave details regarding the mental and physical condition and conduct of 207 inebriates and regarding age, number of previous convictions, religion and education of 333 female inebriates. Dr Gill has generously amplified the data by furnishing me with the register numbers of the 227 inebriates whose after-histories he gives. I have thus been able to obtain the age, number of previous convictions, and education of 184 inebriates, whose conduct after discharge is known, and for 86 inebriates, whose after-histories are known, the mental condition and conduct while in the reformatory. From these data we find that 4 women aged 50 and over are said to be "doing well" after discharge, 1 to be "much improved" and 3 to be "improved," out of 184 inebriates, while of women with over 50 previous convictions, 1 is said to be "doing well," 3 to be "much improved" and 1 to be "improved," while out of 28 said to be doing well, no fewer than 17 are said to be mentally defective to at least some degree.

Now in view of Dr Gill's statements regarding his knowledge of the after-histories of these inebriates, these cases cannot be due to the incompleteness of the record. They show clearly that it is impossible to say that any definite age or any definite number of previous convictions marks off the "possibly reformable" from the "irreformable" inebriate.

From the additional data supplied by Dr Gill, I have worked out the following correlations (see Table XXXII).

These results show that age plays only a very small part in determining reform or relapse, and that the small influence it exerts is in the opposite direction to that which might be expected, for those who relapse are slightly *younger* than those who do well after discharge. It must be remembered, however, that the prostitutes are

much younger than the non-prostitutes. The relationship between relapse and number of previous convictions is rather closer and shows that those who relapse have been convicted more often than those who do well after discharge. This relationship is slightly increased by allowing for age, the partial correlation (age constant) being $-\cdot 33$. While this correlation is quite significant, it is not large enough to enable us to say that any definite number of previous convictions spells irreformability. There is a fairly close relationship between relapse and conduct. Those who behave well while in the reformatory are most likely to do well after discharge. The correlations between relapse and mental condition or education are not significant.

TABLE XXXII.

Variates	Method	No.	Correlation	Remarks
Relapse and age	2 row r	184	$+\cdot 13 \pm \cdot 05$	Barely significant Relapsed are slightly younger
,, ,, number of convictions	2 row r	184	$-\cdot 26 \pm \cdot 05$	Relapsed have more convictions
,, ,, mental condition......	Fourfold	86	$+\cdot 14 \pm \cdot 12$	Not significant
,, ,, conduct	,,	86	$+\cdot 41 \pm \cdot 11$	Relapsed behave worst
,, ,, formal education......	,,	183	$-\cdot 01 \pm \cdot 10$	Not significant
,, ,, effective education ...	,,	86	$+\cdot 22 \pm \cdot 13$	Not significant

There is however a more pressing problem than the determination of the classes of inebriates who are most likely to benefit from treatment. What are the results obtained from Inebriate Reformatories under the present system? To answer this question we must take *all* the inebriates and investigate their after-histories and we find that only 15 °/。 can be said to be doing well for the comparatively short time they were under observation after discharge.

From the data given we can form some impression of the number of inebriates who relapse after various periods of liberty. Unfortunately the information is not given in the most convenient form. Although, for instance, it is stated whether a woman who has been at liberty for three years has relapsed or has been able to keep sober we have no information as to *when* relapse occurred, and it is very desirable that we should know the actual length of time that these inebriates are able to keep sober. All the available information is given in the following table :—

TABLE XXXIII.

Period of Observation	Doing well	Much improved	Improved	Relapsed	Insane, etc.	Totals	Percentage doing well	Percentage doing well and much improved
At least ½ year	33	17	13	100	21	184	17·9	27·2
,, ,, 1 ,,	26	14	13	85	15	153	17·0	26·1
,, ,, 1½ years	21	11	13	76	12	133	15·8	24·1
,, ,, 2 ,,	20	9	11	67	6	113	17·7	25·7
,, ,, 2½ ,,	13	8	6	50	6	83	15·7	25·3
,, ,, 3 ,,	9	5	5	42	5	66	13·6	21·2

The number of women who were under observation for *at least* six months (actually from six months to nearly six years) is 184 and of these 33 are said to be doing well, 17·9 °/ₒ. Similarly 153 were under observation for at least a year and of these 17·0 °/ₒ are said to be doing well. As we increase the period during which the inebriates were under observation, the proportion of successful cases decreases, although somewhat irregularly. In the last column I have taken together those who were "doing well" and those "much improved" and the results are very similar. These results would seem to show that in the great bulk of cases, relapse takes place in the first six months, if at all, and thus it is very desirable that every sentence of reformatory detention should conclude with a period of probation under guardianship in order that every support should be afforded to the inebriate at the time when relapse is most likely to occur. These figures show however also that the proportion of relapses slowly increases with every additional year of freedom so that the danger of relapse is never absent.

(*l*) If we turn to Scotland, we find that the proportion of inebriates who remain sober after discharge is even smaller than in England. Up to the end of 1908, 181 reformatory inmates had been liberated on expiry of sentence in Scotland and of these Dr James C. Dunlop, Inspector under the Inebriates Acts for Scotland, was able to trace the subsequent histories of 172, leaving only 9 who could not be traced. Dr Dunlop states that:—"Of the 172 such drunkards who have been sentenced to detention in these reformatories, and who have completed their sentences, only 12 can be described as completely and satisfactorily reformed, while 160 are more or less failures, a recovery rate of rather less than 7 per cent. Some, a few, of the 160 might be described as partial successes, for the histories of some show that while the drunken habit has not been completely checked, it has been so far moderated as to enable the victim to remain more or less steadily at work and to keep out of the hands of the police. But even accepting such cases as successes, the recovery rate would barely touch 10 per cent.*" Dr Dunlop also states that among females there were 11 successes to 154 failures and among all men there was 1 success to 6 failures. It should be noted that these returns deal with inebriates "who have completed their sentences" and thus excludes cases "discharged, unfit for further treatment." The exact number of such cases is not stated but it is small and will reduce the recovery rate to only a small extent.

These results are accepted by the Scottish Departmental Committee on the Inebriates Acts, and in their Report† they state that:—"As regards the reformation of the persons committed to reformatories, the results have been disappointing. It is found that only 7 or 8 per cent. of the cases received have recovered."

Now these results are considerably worse than those obtained in England, but it must be remembered that all but 5 °/ₒ of the inebriates were traced after discharge so that the after-histories of inebriates are far more complete in Scotland than in England.

* Sixth Report of the Inspector under the Inebriates Acts for Scotland (1908), p. 9.

† p. 15.

(*m*) In Dr Dunlop's Annual Reports there are published, year by year, detailed accounts of the work of the Girgenti Inebriate Reformatory and these provide some valuable data. In the Report for 1906, particulars, up to the end of 1905 and of 1906, of the conduct after discharge of 29 inebriates who were liberated during 1904 and, up to the end of 1906 of 16 inebriates liberated during 1905, are given. It should be noted however that these are only the inebriates who completed their sentences at the Girgenti Reformatory. In addition to these 29 cases we find (p. 13) that 11 inebriates had been transferred to the State Inebriate Reformatory at Perth (for refractory conduct), 3 had been discharged as unfit for reformatory treatment, and 2 had died, so that instead of 29 we must really consider 45 cases. In the same way if we combine the two years 1904 and 1905 in dealing with those under observation for from 1 to 2 years we get 63 inebriates instead of 45. The records of these inebriates after discharge are as follows:—

TABLE XXXIV.

Record after discharge	After 2½ years	After 1½ years	
	1904	1904	1905
Doing well	2	3	3
Not known to have been convicted	—	4	—
"Did well when on licence"	1	1	—
"Poorhouse case"	1	1	—
Address unknown	1	—	1
Relapsed	23	19	12
Dead	3	3	
Discharged, unfit for treatment	3	3	
Transferred to State Inebriate Reformatory at Perth	11	13	
Totals	45	63	

We find then that of 45 inebriates admitted to this reformatory only 2 can be said to be doing well 2½ years after the expiry of their sentences, and similarly out of 63 inebriates admitted only 6 can be said to be doing well 1½ years after the expiry of their sentences. 29 women who completed their sentences were convicted, in 2½ years after discharge, 165 times in all of which 130 convictions were for drunkenness.

One further series from Girgenti may be given. In the Report on this Reformatory for 1908 (dated 16th Feb. 1909) particulars are given of 15 inebriates discharged during 1908. These women have been at liberty for periods ranging from two months to a year and of the 15; 10 were convicted in all 30 times after discharge, while 5 were not subsequently convicted.

It has been stated again and again that these records are incomplete and by no means satisfactory. They provide, however, a *higher* limit to the number of inebriates who do well after detention in reformatories. A large number of inebriates were lost sight of and it is impossible to resist the conclusion that when 50 °/ₒ of the inmates of a reformatory cannot be traced after discharge, the information concerning the remaining 50 °/ₒ must be very incomplete and that in such cases the number of inebriates who actually do well on discharge is considerably less than that given. Further, the categories used vary widely and in many cases are not sufficiently definite, the inebriates are not all under observation for the same length of time, and in many cases the period of observation after discharge is too short to test adequately the permanence of reform. It should also be noted that there is a considerable amount of duplication in these histories; thus many of the inebriates committed from Hull and Birmingham will be included among those discharged from Brentry but the large number of cases of inebriates who could not be traced after discharge from that institution makes it impossible to allow for this. I have summed up, however, in the next table, particulars of 1905 cases and would only call attention to the fact that these histories refer to a somewhat less number of inebriates.

TABLE XXXV. *Summary of Results of Reformatory Treatment of Inebriates.*

Authority	Number discharged	Doing well	Reformed	Much Improved	Improved	Not relapsed	Not convicted
Parker, Brentry	227	75	—	—	—	—	—
Parr (Section I cases only)	133	—	59	—	—	—	—
Dunning, Liverpool	60	—	—	—	—	22	—
Atkinson, Leeds	28	8	—	—	—	—	—
Halketh, Hull	23	1	—	—	—	4	—
Wright, Newcastle	50	4	—	—	—	—	—
Nelson, London	74	—	—	—	—	—	33*
Baggallay, London	80	—	—	—	—	—	42*
Barradaile, Birmingham	21	—	—	—	—	—	8*
After-Care Association	407	82	—	—	—	—	—
Gomme, Farmfield	394	56	—	—	—	—	—
Gill, Langho	227	34	—	17	15	—	—
Dunlop, Scotland	181	12	—	—	—	—	—
Totals	1905	272	59	17	15	26	83*

As it stands, Table XXXV shows that out of 1905 histories of inebriates after discharge, 272 are said to be doing well and 59 to have "reformed" although some

* Not convicted, after discharge, at same police court.

of these were convicted after discharge, 17 were "much improved," 15 were "improved," 26 "did not relapse" and 83 were not convicted, after discharge, at the same police court.

There are two other methods by which we can estimate the results of reformatory detention so far as the reform of the inebriates is concerned. Under the present system, inebriates were first committed to reformatories in 1899 and few were discharged before 1902. Out of the 865 women committed to inebriate reformatories during the three years 1907—9, 129 were so committed for the second time, having already undergone a period of reformatory detention. Further, of these 865 women, only 639 had been discharged up to Nov. 1911 and had been at liberty for periods varying from a few days to less than two years. Yet in that limited time 32 women were again committed to reformatories, 18 for the second time and 14 for the third time.

The proportion of licences which have been revoked also affords some measure of the results of reformatory treatment. The essential features of the licence are that the inebriate must remain under the charge of some responsible person who is under obligation to report the conduct of the inebriate so released and that if the inebriate relapses, the licence is revoked and the inebriate is brought back to the reformatory. Up to the end of 1908, 670 licences had been issued. These 670 cases formed the best section of the inebriates and were selected out of a total of about 3000 as being suitable for discharge on licence. Out of these 670 cases, 247 were revoked so that from these selected cases only 63 °/₀ had regained sufficient self control to enable them to remain sober, even when under supervision, for the short time that elapsed between discharge on licence and expiry of sentence.

In Scotland the results were rather worse. Dr Dunlop, in his evidence before the Scottish Departmental Committee*, gave particulars of the system of licensing in Scotland. 186 licences had been issued and of these 50 were continued to the end of the sentence, 94 were forfeited through drink or bad conduct and 42 had not expired or had been withdrawn for other reasons. Thus 94 licences were forfeited out of 144, or 65 °/₀, and only 35 °/₀ of licensed inebriates kept sober.

(ii) *The Deterrent Effect of the Reformatories.* In view of the failure of the reformatory system to reform more than a small proportion of the inebriates who undergo detention, more and more stress has been laid upon this aspect of the results of reformatory treatment. It is usually urged that, whatever be these results so far as the reform of the inebriates is concerned, the reformatories serve a useful purpose in reducing the amount of public drunkenness by segregating, though only for limited periods, a number of the worst offenders. This is especially the case in Scotland where the experience of Greenock is constantly cited in support of this view. The Greenock Reformatory was opened in 1903 with accommodation for 20, afterwards increased to 30, female inebriates and in their Report for 1909, the Managers "regret to report that so far as they know only three permanent cases of reformation have taken place among the inebriates discharged," but from its

* Minutes of Evidence, p. 17.

inception it has been claimed that the reformatory has exercised a marked effect in reducing drunkenness among women in Greenock. The Chief Constable of Greenock seems to be originally responsible for this view of the results of the establishment of a reformatory in Greenock, but it has since been officially adopted by Dr Dunlop, the Inspector under the Inebriates Acts for Scotland, and by the recent Scottish Departmental Committee on the Inebriates Acts.

Thus in his Report for 1906 (p. viii) Dr Dunlop says: "The benefits obtained from the maintenance of a certified inebriate reformatory may be looked for more in removing the pernicious influence of the worst drunkards. I can quote the experience in Greenock. That town is possessed of a certified inebriate reformatory of sufficient size to deal with all its most degraded drunken women, and since its establishment female apprehensions by the police have diminished by 25 °/₀. Before the establishment of the reformatory they annually averaged 975 but since the reformatory has been in existence that average has fallen to 725."

Further, in his Report for 1908 (p. 9), Dr Dunlop says: "Inebriate reformatories have two functions to fulfil, the one being to give the inebriates a chance of reformation, the other being to segregate the worst of inebriates and save others from their pernicious influence.... It is in fulfilling the second of the two functions, that of saving others from the contaminating influences of the worst of drunkards, that inebriate reformatories are found to be of great value. Greenock during the last five years has had between 20 and 25 of its worst female drunkards secluded in a reformatory, and the result of that has been that the total number of female apprehensions has fallen from a yearly average of fully 1220 to one of 850, a fall of about 30 °/₀, and the Chief Constable is able to report a marked improvement in the condition of the streets and a diminution of the amount of female brawling."

Dr Dunlop then gives the number of females apprehended in Greenock during the last ten years, five years before the opening of its reformatory and five years subsequent to that opening. I have given in addition the number of women proceeded against in Greenock for drunkenness and disorder during the five years 1905—1909 and the number of women committed to the reformatory since it was opened, in Table XXXVI on the following page.

It should be noted that here the average number of female apprehensions before the opening of the reformatory is given as 1221; in his Report for 1906 Dr Dunlop gives this number as 975. These figures were repeated in a Memorandum presented by the Chief Constable of Greenock to the Scottish Departmental Committee on the Inebriates Acts and Dr Dunlop in his evidence said: "The effect of an inebriate reformatory has been appreciated in Greenock, which is the only town which has a reformatory of sufficient size to meet the reasonable requirements of the town. The result of having that reformatory in Greenock has been a reduction of one-third of the female apprehensions." Dr Dunlop's views seem to become stronger as time goes on, for in his 1909 Report he says "The value of a reformatory as a place of segregation has been fully demonstrated at Greenock. In that town the reformatory is of sufficient size to accommodate all the worst of the female drunken pests, and has been

fully taken advantage of, and the removal of these drunken pests from the town has been found to be very beneficial, their removal having resulted in a marked diminution in the number of drunken and riotous scenes in the streets of that town and in a marked diminution in the number of female apprehensions." Finally these views are accepted by the Scottish Departmental Committee on the Inebriates Acts. In their Report (p. 14), they state that: "The result of an energetic enforcement of the Act in Greenock has been that the number of female drunkards coming before the Courts has been reduced by a third,.... We believe that a general enforcement of the Act would show similar results to those obtained in Greenock."

TABLE XXXVI. *Data as to Female Disorderliness in Greenock.*

Year	Number of Female apprehensions		Females proceeded against for drunkenness, etc.	Females admitted to Reformatory
1899	1212	Mean = 1221	—	—
1900	1201		—	—
1901	1311		—	—
1902	1213		—	—
1903	1168		—	19
1904	849	Mean = 849	—	15
1905	964		905	10
1906	999		878	17
1907	790		684	23
1908	643		532	12
1909	—		469	13

Now it is quite clear that the number of female apprehensions has markedly decreased in Greenock in recent years, but is there any evidence that this is due in any considerable extent to the influence of the reformatory? In the first place it should be noted that only *female* inebriates were committed to this reformatory; in fact, in nine years only 22 male inebriates have been committed to reformatories from the whole of Scotland. What then has been the change in the number of males apprehended in Greenock? Figures exactly comparable with those given by Dr Dunlop are not available, but by the kindness of the Master of Polwarth, Chairman of the Prison Commission for Scotland, I have been able to obtain the numbers of males and females proceeded against for drunkenness and disorder in Greenock for the five years 1905—1909. The figures for earlier years are not available owing to a change in the method of publishing the judicial statistics. The results are as follows (Table XXXVII).

We find then that the number of males proceeded against for drunkenness and disorder has fallen at a rather greater rate than the number of females, although no males were committed to the reformatory. It is thus clear that the claim made by the Chief Constable of Greenock and by Dr Dunlop, that the establishment of the

Greenock Reformatory "has resulted in a marked diminution in the number of female apprehensions," cannot be substantiated. If further proof be required, we find it in the returns from other large towns in Scotland, where no special provision

TABLE XXXVII. *Persons proceeded against for Drunkenness and Disorder in Greenock.*

Year	Males	Females
1905	2279	905
1906	2374	878
1907	1870	684
1908	1369	532
1909	1090	469
Decrease	57 °/。	48 °/。

has been made for the treatment of inebriates. In the next table I have given the experience of Leith and of Paisley.

TABLE XXXVIII. *Persons proceeded against for Drunkenness and Disorder in Leith and Paisley.*

Year	Leith		Paisley	
	Males	Females	Males	Females
1905	1120	450	1153	359
1906	1062	479	1288	356
1907	1137	370	1099	322
1908	907	306	955	269
1909	623	238	620	191
Decrease	44·4 °/。	47·1 °/。	46·2 °/。	46·8 °/。

It will be seen that in these towns the numbers of persons proceeded against for drunkenness and disorder have fallen at practically the same rate as in Greenock and that in this respect there is no difference between the sexes. There is a general tendency of recent years for the number of convictions for drunkenness to fall in all the Scotch towns, with the possible exception of Aberdeen, but in some cases the fall started later than in the towns cited. The establishment of a reformatory at Greenock and the segregation for limited periods of a few women have had no appreciable effect on the amount of public drunkenness. It is a matter of regret that no attempt was made by Dr Dunlop or by the Scottish Departmental Committee to get at the actual facts of the case. The figures given above are based on the reports of the Chief

Constables of the various towns. At the time the Chief Constable for Greenock was making such extravagant claims for the results of the establishment of this reformatory, he had in his possession figures which showed that these claims were absolutely untenable. Yet they have been repeated year after year without a word of protest.

The figures given in this section make it abundantly clear that the reformatories fail to reform more than a small proportion of the inebriates who undergo treatment, and that although the greatest stress is now laid on the deterrent effects of the reformatories in reducing the amount of public drunkenness, it has been shown, from the test case selected by the Scottish authorities, that this claim has even less foundation in fact. To only a very small extent can it be said that the reformatories either reform or deter.

IX. *The Fertility of the Inebriates.*

There is however another aspect of the problem which is, from the eugenic standpoint, of far greater importance than the actual amount of public disorder caused by these inebriates. It has already been shown that the majority of these women are only committed to reformatories after long periods of public

TABLE XXXIX. *Fertility of Inebriates.*

Size of family	Married women living with husbands	Married women living apart from husbands	Widows	Single women	Totals
0	17	52	28	160	257
1	10	41	28	70	149
2	11	41	28	21	101
3	19	16	17	15	67
4	14	29	8	5	56
5	18	22	12	4	56
6	22	12	13	1	48
7	21	9	5	1	36
8	13	4	5	—	22
9	9	10	4	—	23
10	6	4	2	—	12
11	1	4	1	—	6
12	6	2	—	—	8
13	6	5	3	—	14
14	3	1	3	—	7
15	—	—	1	—	1
16	—	1	—	—	1
17	—	1	—	—	1
Totals	176	254	158	277	865

drunkenness and even then for very limited times. On the average 12 years elapse between the onset of alcoholism and the *first* committal to the reformatory, while their average age on admission is nearly 40 years. It is therefore of the highest importance that attention should be directed to some of the results of the system by which attempts at reformation are postponed until nearly the close of reproductive life, so that detention in inebriate reformatories has comparatively little effect in reducing their fertility.

In Table XXXIX I have given the distribution of size of family for the 865 female inebriates dealt with in this investigation, giving details separately for married women living with their husbands, married women living apart from their husbands, widows, and single women.

This table is to be read thus: there are 176 married women living with their husbands, and of these 17 had no children, 10 had one child each,...and 3 had 14 children each. It will be seen that no fewer than 50 of the inebriates had at least 10 children each.

These particulars may be summed up as in Table XL, and I have given there also the average ages and the percentage of women under 46 years of age, in each class.

TABLE XL. *Fertility of Inebriates.*

Class	Numbers of women		Total number of children	Average size of family		Average age	Percentage of women under 46
	Total	Childless		Including childless	Excluding childless		
Married: living with husbands...............	176	17	962	5·5	6·1	39·5	77
Married: not living with husbands	254	52	874	3·4	4·3	39·7	79
Widows..................	158	28	543	3·4	4·2	45·4	55
Single women	277	160	210	·8	2·1	34·4	89
Totals	865	257	2589	3·0	4·3	39·1	78

Thus there are 176 married women living with their husbands and of these 17 are sterile. They have produced in all 962 children, an average of 5·5 if we include the childless marriages and of 6·1 if we exclude childless marriages. The average age of these women is 39·5 and 77 °/。 of these are under the age of 46. In all 865 inebriate women, married, widowed and single of whom 257 had no children are responsible for 2589 children, an average of 3·0 if childless women are included and of 4·3 if childless women are excluded.

These families are however incomplete, 78 °/。 of the women being under the age of 46 and 93 °/。 under the age of 55, so that if these women could be traced to the end of their reproductive lives, the actual numbers of their children would be considerably increased. It is therefore of considerable interest to take out the distribution

of fertility for married women, aged 46 and over, who are living with their husbands, and thus deal with families which are practically complete. In all 41 women fulfil these conditions and the distribution of size of family is given in Table XLI.

TABLE XLI. *Distribution of Size of Family of Married Women, living with their Husbands and aged* 46 *and over.*

Size of family	Frequency	Size of family	Frequency
0	4	8	4
1	2	9	2
2	—	10	3
3	4	11	1
4	3	12	2
5	2	13	5
6	4	14	2
7	3	Total	41

Thus of these 41 women, 3 have had 10 children, 1 has had 11 children, 2 have had 12 children, 5 have had 13 children and 2 have had 14 children. In all there are 289 children giving an average of 7·0 if we include the childless marriages and of 7·8 if we exclude childless marriages. It is quite obvious that detention in a reformatory at the age of 40 for a maximum period of three years can have only a very small effect in reducing their fertility.

If we turn to the families of the inebriates who are classed as mentally defective or insane, the picture that is presented to us is a terrible one. The distribution of fertility for each of the four groups is given in Table XLII, while the totals and averages are given in Table XLIII.

Thus 99 married women, living with their husbands, all of them mentally defective, have produced 556 children, an average of 5·6 if we include childless marriages and of 6·2 if we exclude childless marriages. In all 554 feeble-minded inebriates, married, widowed, and single, of whom 165 were childless, have given birth to 1672 children and it is quite certain that the number will be considerably increased before the end of reproductive life.

These results are, of course, precisely what might have been expected. A long series of investigations into the size of families of different classes has made it abundantly clear that there is a marked differentiation in fertility, that degenerate stocks have, not smaller, but larger families than sound stocks.

In Table XLIV I have given, from Professor Pearson's Robert Boyle Lecture "The Scope and Importance to the State of the Science of National Eugenics*," the average size of family of various pathological and normal stocks. The "English

* 3rd Edition, p. 35.

Middle Class" series has been excluded since the data refer to the middle of last century, before the fall in the birth rate had taken place.

TABLE XLII. *Fertility of Mentally Defective Inebriates.*

Size of family	Married women living with husbands	Married women not living with husbands	Widows	Single women	Totals
0	10	34	16	105	165
1	5	23	17	48	93
2	4	28	19	17	68
3	11	11	10	11	43
4	8	16	6	4	34
5	10	16	9	1	36
6	15	7	8	1	31
7	9	6	2	1	18
8	8	3	4	—	15
9	5	9	3	—	17
10	4	4	1	—	9
11	1	2	1	—	4
12	4	2	—	—	6
13	3	3	2	—	8
14	2	1	2	—	5
15	—	—	—	—	—
16	—	1	—	—	1
17	—	1	—	—	1
Totals......	99	167	100	188	554

TABLE XLIII. *Fertility of Mentally Defective Inebriates.*

Class	Numbers of women		Total numbers of children	Average size of family	
	Total	Childless		Including childless	Excluding childless
Married women living with husbands..................	99	10	556	5·6	6·2
Married women not living with husbands	167	34	617	3·7	4·6
Widows.......................	100	16	350	3·5	4·2
Single women	188	105	149	·8	1·8
Totals	554	165	1672	3·0	4·3

TABLE XLIV. *Fertility in Pathological and Normal Stocks.* (*Childless Marriages excluded.*)

(*a*) *Pathological.*

Class	Authority	Nature of marriage	Average size of family
Deaf-mutes, England	Schuster	Probably completed	6·2
Deaf-mutes, America	„	„ „	6·1
Tuberculous stock	Pearson	„ „	5·7
Albinotic stock	„	„ „	5·9
Insane stock	Heron	„ „	6·0
Edinburgh degenerates	Eugenics Lab.	Incomplete	6·1
London mentally defective	„	„	7·0
Manchester mentally defective	„	„	6·3
Criminals	Goring	Complete	6·6

(*b*) *Normal.*

Class	Authority	Nature of marriage	Average size of family
Family records	Pearson	Completed	5·3
English intellectual class	„	All completed marriages	4·7
Working class, N. S. W.	Powys	Completed	5·3
Danish professional class	Westergaard	15 years at least	5·2
Danish working class	„	25 „ „ „	5·3
Edinburgh normal artisan	Eugenics Lab.	Incomplete	5·9
London normal artisan	„	„	5·1

Thus the average size of family in 9 series of pathological stocks is 6·2 and among 7 series of normal stocks is 5·3. The average completed family among the inebriates is 7·8 *.

The numbers given, however, refer to the gross fertility of the inebriates and it would have been of great interest to have had some estimate of their *net* fertility. The numbers of children, alive and dead, are given in the Report, but as the ages at death are not given, the data cannot be used. In the same way the table in the Report giving the age at death of a number of these children is of no use without a

* A considerable amount of time was spent in investigating the relationships between fertility and the other characters but as the women had to be divided into four civil-status groups, the correlations were rarely significant and often contradictory.

statement of the numbers who survive the ages given, and it is unfortunate that so much time and trouble have been wasted in collecting data which could give no solution of the problem. Before the problem of *net* fertility can be dealt with, we require to know the number of children born and the numbers who die in the first, second, third, etc. year of life, and it is to be hoped that it may be possible to include this information in future Reports.

What is the future of the survivors of these children? In some cases, it is true, mental defect is accidental, but in the bulk of cases it is undoubtedly inherited. In the associated field of insanity, I have shown* from Dr Urquhart's data, that out of 392 children, one of whose parents had been insane, no fewer than 93, equal to 24 °/ₒ, had become insane up to the date of record which does not give a completed history, and this leaves out of account all forms of mental defect less grave than certifiable insanity. Numerous pedigrees show how interchangeable in heredity are the various forms of mental defect and insanity. Quite apart, also, from heredity, it is certain that these alcoholic parents are unfit to train or have charge of children. Indeed nearly all the inebriates committed under Section I of the Act come to the reformatory on the ground of cruelty to children. The only conclusion that can be reached is that such children were better "not born."

X. *Conclusions.*

The publication by Dr Branthwaite of this valuable collection of data concerning the condition of the inebriate on admission to the reformatory and her past history marks an important advance in the study of extreme alcoholism; if any criticism be offered, this is done with a full sense of the value of the data already published, and it is to be hoped the publication of these records will be continued with the modifications and additions which experience has shown to be needful. It has already been pointed out that a statement of the number of dead children is useless unless the ages of both dead and living are given and it will be better to give instead, in future Reports, the number of children who die in the first year of life. In dealing with the duration of alcoholism, it would be of considerable advantage to have given the time which elapsed between the onset of alcoholism and the first conviction. The family histories as given in the Report are of comparatively little value owing to the fact that no distinction is made between cases in which no information was obtained and those in which the relatives were normal. A definite statement of the presence or absence of the condition dealt with should be given in every case—for the normal as well as for the abnormal—since it is of no use to be told that an inebriate had two insane brothers unless we are at the same time told how many brothers and sisters were *not* insane. But the most urgent need is a definite statement of the *result* of reformatory treatment in each case. The probationary year after discharge which is provided for in the new Inebriates Bill will furnish the necessary data and will form one of the most valuable features of that measure.

* "A First Study of the Statistics of Insanity and the Inheritance of the Insane Diathesis." *Galton Memoirs*, II. p. 17.

From the present data the following conclusions may, I think, be legitimately drawn:—

(i) In dealing with the condition of the inebriates on admission to the reformatories, the one fact which dominates all others is the very high proportion of mental defect among the inebriates; two-thirds of the women are mentally defective when judged in the reformatories out of reach of alcohol. Further, a large proportion of the women begin to drink practically at the earliest age at which they can obtain access to alcohol and the amount of mental defect among those who have been drinking for many years is only slightly greater than that among those who are at the beginning of their alcoholic careers. There is a close relationship between the intensity of alcoholism and the mental condition of the inebriates but no relationship with their physical condition. All this lends support to the view that the mental defect of the inebriate is not a gradual growth; it is born, not bred; that "inebriety is more an incident in the life of the inebriate than the cause of his mental defect."

(ii) The long list of after-histories of inebriates proves that even during the limited time they were under observation, of only a very small proportion could it be said that they were doing well.

(iii) The deterrent influence of the reformatories appears to be *nil* and the numbers of inebriates committed to reformatories were too small, and the periods of detention too short, to affect appreciably the number of convictions for drunkenness.

(iv) These inebriates, in common with all other degenerate stocks, had not smaller but larger families than sound stocks, and there can be no doubt that in a large proportion of cases the mental defect of the parents would be transmitted to the children. But putting aside any question of heredity, these extreme alcoholists are quite unfit to be the custodians of young children.

What, then, of the future? The recently introduced Inebriates Bill, although it contains many excellent provisions, will touch only the fringe of the question. It provides for the compulsory committal of the *non*-criminal inebriate on the petition of relatives or friends; it simplifies the committal of the criminal inebriate; it provides for graduated sentences and a year's probation at the end of each sentence, a provision which will at least make perfectly clear the failure of the reformatories to reform the inebriates. The Bill, however, continues the system of dealing with inebriety and mental defect in water-tight compartments and to deal with the feeble-minded inebriate not as feeble-minded but as an inebriate, notwithstanding the strong recommendation to the contrary of the Royal Commission on the Feeble-Minded. The Bill is based on the assumption that the present system is so far successful and requires only modification to make it completely so. But it has been clearly shown, I think, that the present system is a failure. The results already given show that for the inebriates there is little hope of reform. Even if you bring them under reformatory treatment at the earliest possible age, you will, for just as long as you keep them segregated, reduce *pro tanto* their fertility; you will not however, except in a few cases, restore to them a normal measure of self-control. The precise mental condition of those who appear to be normal when in the reformatories out of reach

of alcohol must be a matter for future investigation, but this class amounts to only one-third of the whole; two-thirds of the inebriates are mentally defective, and we must deal with the mental defect of which inebriety is only a sign, not in the police court, not in the inebriate reformatory but *ab initio* in the school for mentally defective children. Any Bill which ignores the mental defect of at least the bulk of the inebriates will fail to provide a real solution of this grave social problem.

This defect has, however, been remedied in the Mental Deficiency Bill* introduced by the Home Secretary and it is somewhat unfortunate that this Bill, which marks such an important advance in the treatment of mental defect, should include provisions so wide and so vague that needless hostility is certain to be aroused.

The persons subject to be dealt with under the Bill, i.e., to be sent or transferred to and detained in an institution for defectives or placed under guardianship, are defined in Section 17 as follows:

17. (1) Save as expressly provided by this Act, the following persons, and no others, shall be subject to be dealt with under this Act, that is to say, persons who are defectives† and

(*a*) who are found wandering about, neglected, or cruelly treated;

(*b*) who are charged with the commission of any offence, or are undergoing imprisonment or penal servitude or detention in a place of detention, or a reformatory, or industrial school, or an Inebriate Reformatory;

(*c*) who are habitual drunkards within the meaning of the Inebriates Acts, 1879 to 1900;

(*d*) in whose case, being children discharged on attaining the age of sixteen from a special school or class established under the Elementary Education (Defective and Epileptic Children) Act, 1899, such notice has been given by the local education authority as is hereinafter mentioned;

(*e*) in whose case it is desirable in the interests of the community that they should be deprived of the opportunity of procreating children;

(*f*) in whose case such other circumstances exist as may be specified in any order made by the Secretary of State, as being circumstances which make it desirable that they should be subject to be dealt with under this Act.

(2) The following classes of persons shall be deemed to be defectives within the meaning of this Act:

(*a*) Idiots; that is to say, persons so deeply defective in mind from birth or from an early age as to be unable to guard themselves against common physical dangers;

* Mr Stewart's Feeble-Minded Persons (Control) Bill and Mr Hills' Mental Defect Bill have each served a useful purpose in directing attention to the urgent need for further legislation for the care and control of the feeble-minded, but they are very unlikely to make further progress and need not be considered here in detail.

† It should be noted that to be subject to the provisions of this Bill, a person must fall under one of the classes of Paragraph 1 and also under one of the classes of Paragraph 2 of Section 17.

(*b*) Imbeciles; that is to say, persons who are capable of guarding themselves against common physical dangers, but who are incapable of earning their own living by reason of mental defect existing from birth or from an early age;

(*c*) Feeble-minded persons; that is to say, persons who may be capable of earning their living under favourable circumstances, but are incapable, through mental defect existing from birth or from an early age,

(i) of competing on equal terms with their normal fellows; or

(ii) of managing themselves and their affairs with ordinary prudence;

(*d*) Moral imbeciles; that is to say, persons who from an early age display some mental defect coupled with strong vicious or criminal propensities on which punishment has little or no deterrent effect;

(*e*) Mentally infirm persons; that is to say, persons who through mental infirmity arising from age or the decay of their faculties are incapable of managing themselves or their affairs.

Now no information is given as to the principles on which clause 1 *e* is to be applied. Does it include the syphilitic or those who have been insane? Again, not the slightest hint has been given of the class of persons who might be included under clause 1 *f*. Further, clause 1 *d*, which deals with the defective and epileptic child and is qualified by section 24, can only be applied if the local authority are of opinion that it would be for the benefit *of the child* that it should be dealt with under the Bill, and it might reasonably be held that it would be for the benefit of such a child that he should be allowed the opportunity of testing whether he is capable of competing on equal terms with his normal fellows or of managing himself or his affairs with ordinary prudence.

The definition of a "feeble-minded person" is admittedly difficult and has not been got over in the Bill as it at present stands. It is difficult to say that individuals are incapable of competing on equal terms with their normal fellows until they have had an opportunity of trying to do so, and this opportunity gives the chance both of crime and of parenthood which it should be our object to lessen.

So far as the inebriates are concerned, if it is intended that the mentally defective inebriate shall be dealt with under the provisions of the Mental Deficiency Bill, while inebriates who are of normal mental condition at least while in the reformatories are dealt with under the Inebriates Bill, then these Bills will be more effective, but it is most important that this should be clearly stated.

Provision should be made for keeping in touch with every convicted inebriate by means of a General Register of Inebriates, and this is just as urgent as the need for a General Register of the Insane on which we have previously insisted. The General Register of Feeble-Minded proposed in the new Mental Deficiency Bill provides the first step in this direction. Such a register should be open to local

authorities and be based on finger-print records. A person who has been convicted from 50 to 200 times of drunkenness is just as obnoxious socially as the habitual criminal, and is equally in need of identification.

So much for the treatment of the inebriate *after* conviction, but his treatment *before* conviction is of far greater importance. It is absolutely essential that the inebriate should be dealt with at the earliest possible age. It is the Board of Education which must be aroused to action rather than the Home Office. There is urgent need for close investigation into the relationship between the mentally defective inebriate and the mentally defective child in the special schools. We ought to be able to trace the histories of at least the younger inebriates back to their school days and at the same time to begin to keep a permanent record of the after-histories of those who pass through the special schools for mentally defective children. If it be established, and all the available evidence tends to this conclusion, that the children who in after life become mentally defective inebriates are already a differentiated class in the schools, then the obvious solution of the problem is the segregation *from school age* of the mentally defective child not only for his own benefit but also for the benefit of the community.

In this, as in so many social problems, the great hindrance to progress is our lack of knowledge, knowledge which could be gained by relatively little expenditure of time and energy through the cooperation of State Departments, local authorities, and social workers. Only with such knowledge is it possible to legislate effectively in the great bulk of social problems.

I desire, in conclusion, to express my thanks to Miss H. Gertrude Jones for drawing the diagrams which illustrate this memoir and to Professor Karl Pearson for his ever-ready help and encouragement throughout the progress of the work.

APPENDIX.

INDEX TO THE TABLES.

	Age on admission	Age at onset	Duration	No. of convictions	Mental condition	Education	Physical condition	Organic disease	Conduct	Civil status	Occupation	Morality
Age on admission......	—	1	2	5	3	4	6	7	8	9	10	11
Age at onset............	1	—	12	21	13	14	15	16	17	18	19	20
Duration	2	12	—	25	22	23	24	26	27	28	29	30
No. of convictions ...	5	21	25	—	31	32	33	34	35	36	37	38
Mental condition	3	13	22	31	—	39	40	41	42	43	44	45
Education	4	14	23	32	39	—	46	47	48	49	50	51
Physical condition ...	6	15	24	33	40	46	—	61	62	63	64	65
Organic disease.........	7	16	26	34	41	47	61	—	54	55	56	57
Conduct..................	8	17	27	35	42	48	62	54	—	58	59	60
Civil status	9	18	28	36	43	49	63	55	58	—	52	53
Occupation	10	19	29	37	44	50	64	56	59	52	—	66
Morality	11	20	30	38	45	51	65	57	60	53	66	—

The Index Number of the correlation table between any two characters is to be found by reading to the right of one of the characters and under the other.

ABBREVIATIONS USED IN THE TABLES.

Mental condition	G. = Good D. = Defective V.D. = Very defective I. = Insane
Education *	S. (*A*) = Superior R.W. (*B*) = Read and write well R. (*C*) = Read and write imperfectly N. (*D*) = Neither read nor write
Physical condition	F. = Fit for hard work U. = Unfit for hard work
Organic disease	N. = No organic disease G.D. = General debility H.D. = Heart disease S. = Syphilis O. = Other diseases

Conduct *	W. (*A*) = Well-behaved M. (*B*) = Manageable T. (*C*) = Troublesome V.T. (*D*) = Very troublesome
Civil status	S. = Single M.W. = Married: with husband M.A. = Married: apart from husband W. = Widow
Occupation	H. = Housewife O. = Other occupation N. = No occupation
Morality	M. = Moral I. = Immoral

* The letters *A*, *B*, *C*, *D* are used in Dr Branthwaite's Report.

TABLES 1—4.

			Age on admission																				
			16–18	19–21	22–24	25–27	28–30	31–33	34–36	37–39	40–42	43–45	46–48	49–51	52–54	55–57	58–60	61–63	64–66	67–69	70–72	73–75	Totals
1.	Age at onset of alcoholism	14–15	4	2	2	6	2	3	2	...	...	1	...	2	...	...	...	...	1	...	...	...	25
		16–17	1	9	14	23	21	7	12	7	3	1	2	1	...	1	...	1	...	...	...	...	103
		18–19	...	...	12	23	44	24	21	21	8	11	5	1	...	...	...	...	...	...	...	...	170
		20–21	...	...	1	4	17	14	16	15	12	2	1	4	...	...	1	1	...	...	...	...	88
		22–23	...	...	...	6	5	15	8	6	3	3	2	...	1	1	...	...	...	...	...	...	50
		24–25	...	...	...	...	6	7	7	3	8	3	...	...	1	...	...	...	1	...	...	...	36
		26–27	...	...	...	...	...	10	12	13	4	2	1	...	...	2	...	...	...	1	...	...	45
		28–29	...	...	...	...	...	2	10	10	12	5	3	...	1	...	...	...	...	...	...	...	43
		30–31	...	...	...	...	...	3	15	10	12	8	2	2	...	...	1	...	...	...	...	...	53
		32–33	...	...	...	...	...	...	3	13	12	15	6	...	3	...	...	...	...	...	...	...	52
		34–35	...	...	...	...	...	...	...	7	12	10	6	3	2	...	...	...	1	...	...	...	41
		36–37	...	...	...	...	...	...	...	1	8	4	6	2	1	...	...	1	...	...	...	...	23
		38–39	...	...	...	...	...	...	...	...	1	11	8	6	4	1	...	1	1	...	...	...	33
		40–41	...	...	...	...	...	...	...	...	...	3	7	6	2	1	2	...	1	...	...	...	22
		42–43	...	...	...	...	...	...	...	...	...	2	7	2	1	2	1	1	...	...	1	...	17
		44–45	...	...	...	...	...	...	...	...	...	...	1	4	10	3	1	1	2	...	...	...	22
		46–47	...	...	...	...	...	...	...	...	...	...	...	4	4	6	1	2	1	1	...	...	19
		48–49	...	...	...	...	...	...	...	...	...	...	...	...	3	...	4	...	3	1	...	...	11
		50–51	...	...	...	...	...	...	...	...	...	...	...	...	...	4	2	1	...	...	...	...	7
		52–53	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	2
		54–55	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
		56–57	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		58–59	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1
		60–61	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
2.	Duration of alcoholism	1–2	2	...	...	...	...	3	1	1	...	...	...	...	...	...	...	...	...	...	...	...	7
		3–4	3	8	4	4	1	4	8	4	4	4	2	1	...	...	...	...	...	...	...	...	47
		5–6	...	3	17	7	8	6	15	13	10	6	9	7	4	2	...	...	1	...	...	...	108
		7–8	...	...	8	27	10	9	11	14	9	12	10	2	7	3	1	...	...	...	...	...	123
		9–10	...	...	...	18	39	18	11	12	20	11	6	8	7	7	4	...	...	...	...	...	161
		11–12	...	...	...	5	25	16	7	11	10	14	7	5	1	2	2	1	...	1	...	...	107
		13–14	...	...	...	1	10	10	7	1	6	2	3	1	3	1	...	...	...	...	...	...	45
		15–16	...	...	...	...	2	19	22	6	8	9	6	3	3	1	2	2	3	...	...	...	86
		17–18	...	...	...	...	...	...	16	15	2	3	1	...	...	1	...	2	1	...	...	...	41
		19–20	...	...	...	...	...	...	8	22	13	2	3	2	5	...	2	...	3	2	1	2	65
		21–22	...	...	...	...	...	...	...	7	7	3	...	...	...	...	...	...	...	...	...	...	17
		23–24	...	...	...	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...	6
		25–26	...	...	...	...	...	...	...	...	...	12	3	...	1	...	...	2	1	...	...	...	19
		27–28	...	...	...	...	...	...	...	...	...	2	2	...	...	...	...	...	...	...	...	...	4
		29–30	...	...	...	...	...	...	...	...	...	1	5	4	2	2	1	...	...	...	1	...	16
		31–32	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	...	...	2
		33–34	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1
		35–36	...	...	...	...	...	...	...	...	...	...	...	2	...	1	...	1	...	...	...	...	4
		37–38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		39–40	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	1	...	...	5
		......	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		49–50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
3.	Mental condition	G.	2	4	9	28	35	35	40	45	29	33	23	8	6	4	5	...	1	3	1	...	311
		D.	3	4	16	28	49	46	60	49	58	41	31	24	20	15	8	8	4	1	1	2	468
		V.D.	...	1	3	5	9	2	3	10	7	6	3	5	5	1	...	1	7	...	...	...	68
		I.	...	2	1	1	2	2	3	2	1	1	...	...	2	1	...	...	...	...	...	...	18
4.	Education	S.	...	...	1	1	5	5	5	2	3	4	3	1	1	...	1	1	...	...	1	...	34
		R.W.	1	4	8	25	27	28	39	38	26	32	17	7	4	8	2	1	1	...	...	...	268
		R.	4	6	19	33	50	46	49	52	51	37	30	20	21	10	6	6	6	3	1	1	451
		N.	...	1	1	3	13	6	13	14	15	8	7	9	7	3	4	1	5	1	...	1	112
		Totals	5	11	29	62	95	85	106	106	95	81	57	37	33	21	13	9	12	4	2	2	865

Tables 5—11.

			Age on admission																				
			16–18	19–21	22–24	25–27	28–30	31–33	34–36	37–39	40–42	43–45	46–48	49–51	52–54	55–57	58–60	61–63	64–66	67–69	70–72	73–75	Totals
5.	Number of convictions	0–4	...	...	1	3	7	8	13	22	11	9	8	4	1	2	...	...	...	...	...	...	89
		5–9	1	2	8	14	17	13	15	19	10	11	11	3	3	3	2	1	...	...	1	...	134
		10–14	3	3	10	10	14	19	15	13	4	14	8	4	4	4	1	1	...	2	...	...	129
		15–19	1	2	4	9	15	12	12	8	18	9	8	6	6	1	4	...	...	1	1	1	118
		20–24	...	2	4	4	11	5	11	10	9	10	5	3	4	1	...	...	...	...	...	...	79
		25–29	...	1	1	7	10	11	8	4	12	2	4	3	1	3	...	1	2	...	...	...	70
		30–34	...	1	...	7	7	5	8	5	3	5	2	1	2	3	1	1	2	1	...	...	54
		35–39	...	...	1	2	6	5	6	5	8	4	2	3	2	...	1	1	2	...	...	...	48
		40–44	...	...	...	2	2	1	5	1	5	4	2	1	5	1	1	1	1	...	...	...	32
		45–49	...	...	...	1	2	3	4	4	2	6	2	2	1	1	1	...	2	...	...	...	31
		50–54	...	...	...	2	...	2	3	1	4	1	4	...	1	...	1	1	...	...	...	1	21
		55–59	...	...	...	...	...	...	...	3	2	2	...	1	...	...	...	...	2	...	...	...	10
		60–64	...	...	...	...	1	...	1	1	1	1	...	1	...	1	...	...	...	...	...	...	7
		65–69	...	...	...	...	...	...	3	4	1	...	...	1	...	1	...	...	...	...	...	...	10
		70–74	...	...	...	1	1	...	...	2	1	...	...	1	1	...	1	1	...	...	...	...	9
		75–79	...	...	...	...	...	...	1	1	...	...	...	...	1	...	...	...	...	...	...	...	3
		80–84	...	...	...	...	...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	2
		85–89	...	...	...	...	...	...	...	1	...	...	...	1	1	...	...	...	...	...	...	...	3
		90–94	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	2
		95–99	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1
		100–104	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		105–109	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		110–114	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	2
		115–119	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		120–124	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1
		125–129	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1
		130–134	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1
		135–139	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1
		140–144	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		145–149	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1
		150–154	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		155–159	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1
		160–164	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		165–169	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		170–174	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
		175–179	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1
6.	Physique	F.	5	10	27	49	78	61	78	78	58	53	33	16	13	6	2	3	...	...	...	1	571
		U.	...	1	2	13	17	24	28	28	37	28	24	21	20	15	11	6	12	4	2	1	294
7.	Organic disease	N.	5	9	23	46	72	55	71	69	53	51	31	13	11	5	2	2	...	...	...	1	519
		G.D.	...	1	...	8	7	12	16	10	17	14	11	13	8	10	9	3	10	2	...	1	152
		H.D.	...	...	3	4	5	6	6	10	8	8	6	4	5	3	1	2	1	1	...	...	73
		S.	...	1	3	...	4	3	5	5	6	...	3	1	2	...	...	...	...	...	...	...	33
		O.	...	...	...	4	7	9	8	12	11	8	6	6	7	3	1	2	1	1	2	...	88
8.	Conduct	W.	2	7	12	46	59	59	66	71	71	61	49	25	27	15	9	6	8	3	...	1	597
		M.	...	2	9	9	20	20	27	22	14	9	6	10	4	3	1	2	3	1	1	1	164
		T.	1	1	6	5	9	4	7	10	5	7	1	2	1	1	2	1	...	...	...	...	63
		V.T.	2	1	2	2	7	2	6	3	5	4	1	...	1	2	1	...	1	...	1	...	41
9.	Civil status	S.	5	11	23	33	58	18	37	24	21	13	11	8	4	3	4	2	1	...	...	1	277
		M.W.	...	...	3	9	10	22	19	37	15	20	16	9	10	3	1	1	1	...	...	...	176
		M.A.	...	...	3	16	23	32	37	30	35	28	11	8	16	6	2	2	3	1	1	...	254
		W.	...	...	...	4	4	13	13	15	24	20	19	12	3	9	6	4	7	3	1	1	158
10.	Occupation	H.	...	...	2	10	11	17	22	30	13	16	14	9	9	4	1	1	...	1	...	...	160
		O.	3	5	15	34	42	36	51	56	56	50	34	25	22	15	11	5	10	3	1	2	476
		N.	2	6	12	18	42	32	33	20	26	15	9	3	2	2	1	3	2	...	1	...	229
11.	Morality	M.	...	3	3	24	20	36	45	62	39	49	35	24	25	19	13	6	9	2	2	2	418
		I.	5	8	26	38	75	49	61	44	56	32	22	13	8	2	...	3	3	2	...	...	447
	Totals		5	11	29	62	95	85	106	106	95	81	57	37	33	21	13	9	12	4	2	2	865

TABLES 12—20.

No.			14–15	16–17	18–19	20–21	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	42–43	44–45	46–47	48–49	50–51	52–53	54–55	56–57	58–59	60–61	Totals
			Age at onset of alcoholism																								
12.	Duration of alcoholism	1–2	1	1	...	..	...	...	...	...	3	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	7
		3–4	3	8	3	1	4	1	3	1	6	3	3	3	1	2	3	1	1	...	...	...	...	...	...	...	47
		5–6	2	9	10	4	5	6	4	7	9	9	9	5	5	4	6	4	4	3	2	...	...	...	...	1	108
		7–8	2	17	16	8	2	6	10	5	10	5	10	3	12	4	2	4	4	...	3	...	...	...	...	...	123
		9–10	2	10	36	13	14	6	8	9	10	14	6	5	4	6	1	8	5	3	1	...	...	...	...	...	161
		11–12	3	13	19	10	7	4	8	8	4	11	6	3	4	1	1	1	1	1	1	...	...	...	1	...	107
		13–14	1	10	10	5	2	...	3	4	2	2	1	1	2	1	1	...	...	...	...	...	...	...	...	...	45
		15–16	5	7	20	12	5	6	2	5	6	4	3	1	3	1	1	1	2	2	...	...	...	...	...	...	86
		17–18	...	6	11	13	1	3	2	1	...	...	...	...	1	...	1	1	...	1	...	...	...	...	...	...	41
		19–20	2	10	17	11	3	2	1	2	2	3	2	...	...	2	...	2	2	1	...	2	1	...	...	...	65
		21–22	...	3	8	2	3	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17
		23–24	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
		25–26	...	...	10	3	2	...	...	1	...	...	...	1	1	1	...	...	...	...	...	...	..	...	...	...	19
		27–28	...	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
		29–30	1	2	3	4	1	1	2	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	16
		31–32	...	...	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	2
		33–34	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		35–36	2	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
		37–38	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		39–40	...	1	...	2	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
		......	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		49–50	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
13.	Mental condition	G.	7	31	57	31	20	16	17	26	21	20	19	10	11	9	4	3	5	2	2	...	...	...	...	...	311
		D.	12	60	92	46	26	16	25	13	31	26	20	13	22	11	12	15	11	8	5	2	1	...	1	...	468
		V.D.	6	7	17	9	3	3	1	4	...	5	1	...	...	2	1	4	3	1	...	...	...	...	...	1	68
		I.	...	5	4	2	1	1	2	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	18
14.	Education	S.	...	2	4	3	2	1	1	4	5	1	1	1	2	1	2	1	2	...	...	1	...	...	...	...	34
		R.W.	5	35	50	29	15	15	14	14	20	17	14	10	10	6	2	4	6	...	2	...	...	...	...	...	268
		R.	16	56	94	43	24	16	27	19	24	28	21	10	15	11	9	15	11	6	3	1	...	...	1	1	451
		N.	4	10	22	13	9	4	3	6	4	6	5	2	6	4	4	2	...	5	2	...	1	...	...	...	112
15.	Physique	F.	21	78	130	62	35	28	25	32	33	41	24	13	17	9	10	7	4	...	1	...	1	...	...	...	571
		U.	4	25	40	26	15	8	20	11	20	11	17	10	16	13	7	15	15	11	6	2	...	...	1	1	294
16.	Organic disease	N.	20	71	115	57	33	25	24	29	32	36	22	12	17	7	8	5	4	...	1	...	1	...	...	...	519
		G.D.	2	16	17	11	5	3	11	4	12	5	10	5	7	6	3	11	9	8	6	1	...	...	..	...	152
		H.D.	1	6	15	7	7	1	3	3	4	2	5	3	2	5	1	3	3	1	...	...	...	...	1	...	73
		S.	1	3	10	4	1	...	2	3	...	2	2	1	1	1	...	...	1	1	...	...	...	...	...	...	33
		O.	1	7	13	9	4	7	5	4	5	7	2	2	6	3	5	3	2	1	...	1	...	...	...	1	88
17.	Conduct	W.	10	67	105	54	32	26	29	34	42	41	32	18	28	16	15	16	13	9	7	...	1	...	1	1	597
		M.	6	21	41	21	13	6	11	7	5	7	6	3	3	4	2	4	3	...	...	1	...	...	...	...	164
		T.	5	10	17	9	1	2	3	1	3	2	...	1	2	2	...	2	2	1	...	...	...	...	...	...	63
		V.T.	4	5	7	4	4	2	2	1	3	2	3	1	...	...	...	...	1	1	...	1	...	...	...	...	41
18.	Civil status	S.	18	66	76	31	11	7	11	12	11	8	4	4	2	4	3	2	2	3	1	1	...	...	...	...	277
		M.W.	2	10	23	14	10	12	9	10	18	14	13	3	15	8	3	4	5	2	1	...	...	...	...	...	176
		M.A.	5	17	51	31	21	10	14	13	18	20	11	4	13	4	5	9	2	1	3	1	...	...	1	...	254
		W.	...	10	20	12	8	7	11	8	6	10	13	12	3	6	6	7	10	5	2	...	1	...	...	1	158
19.	Occupation	H.	2	6	21	12	10	9	7	9	17	15	11	2	15	7	2	5	5	2	2	...	...	...	1	...	160
		O.	14	58	88	51	27	15	25	24	24	30	23	15	16	12	11	16	11	8	5	1	1	...	...	1	476
		N.	9	39	61	25	13	12	13	10	12	7	7	6	2	3	4	1	3	1	...	1	...	...	...	...	229
20.	Morality	M.	6	21	46	39	27	20	22	19	34	32	30	13	28	15	12	18	15	9	7	2	1	...	1	1	418
		I.	19	82	124	49	23	16	23	24	19	20	11	10	5	7	5	4	4	2	...	...	...	...	...	...	447
	Totals		25	103	170	88	50	36	45	43	53	52	41	23	33	22	17	22	19	11	7	2	1	...	1	1	865

Tables 21—24.

21.

Number of convictions	Age at onset of alcoholism: 14–15	16–17	18–19	20–21	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	42–43	44–45	46–47	48–49	50–51	52–53	54–55	56–57	58–59	60–61	Totals
0–4	...	2	5	6	4	4	6	6	13	10	10	4	7	3	1	3	3	...	2	...	...	...	...	...	89
5–9	2	11	26	10	9	7	5	9	10	10	6	5	6	5	3	2	3	1	3	1	...	...	...	...	134
10–14	3	15	22	14	9	5	10	5	10	4	7	3	5	2	4	4	3	3	1	...	...	...	...	...	129
15–19	3	14	19	10	7	4	4	8	8	6	7	3	6	2	4	3	5	4	...	...	1	...	...	...	118
20–24	2	10	13	14	1	4	8	3	5	5	3	4	3	1	1	2	...	...	...	...	...	...	...	...	79
25–29	2	8	18	9	4	3	2	1	2	7	4	2	1	2	...	3	1	1	...	...	...	...	...	...	70
30–34	5	10	12	3	5	1	...	4	1	4	...	...	1	1	1	2	2	...	1	...	...	...	1	...	54
35–39	1	7	16	3	4	3	4	2	...	2	...	...	1	2	1	...	...	1	...	...	...	...	...	1	48
40–44	2	4	8	3	1	1	1	1	2	2	...	1	1	1	1	3	...	...	..	...	...	...	...	...	32
45–49	1	3	12	3	...	2	2	...	...	...	3	...	1	3	...	...	...	1	...	...	...	...	...	...	31
50–54	1	5	6	2	1	...	...	...	1	1	...	1	1	...	1	...	...	...	...	1	...	...	...	...	21
55–59	1	2	3	...	...	1	...	2	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	10
60–64	...	1	...	2	1	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7
65–69	1	3	3	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10
70–74	...	3	1	3	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	9
75–79	...	1	1	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	3
80–84	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
85–89	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
90–94	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
95–99	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
100–104	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
105–109	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
110–114	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
115–119	...	...	1	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	1
120–124	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
125–129	...	...	1	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	1
130–134	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
135–139	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
140–144	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145–149	...	...	1	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	1
150–154	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
155–159	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
160–164	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
165–169	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
170–174	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
175–179	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
Totals	25	103	170	88	50	36	45	43	53	52	41	23	33	22	17	22	19	11	7	2	1	...	1	1	865

			Duration of alcoholism: 1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	17–18	19–20	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	41–42	43–44	Totals
22.	Mental condition	G.	4	24	46	48	62	39	13	25	13	16	4	1	5	1	5	1	...	2	...	2	...	...	311
		D.	3	20	54	64	87	62	29	53	24	33	10	4	12	3	5	1	1	1	...	2	...	...	468
		V.D.	...	1	7	8	11	5	2	5	4	11	3	1	2	...	5	...	...	1	...	1	...	1	68
		I.	...	2	1	3	1	1	1	3	...	5	...	...	...	...	1	...	...	...	...	...	...	..	18
23.	Education	S.	...	4	7	3	9	4	1	4	1	1	...	...	...	...	...	...	...	...	...	...	...	...	34
		R.W.	4	17	33	48	46	35	12	22	16	17	5	1	5	...	5	1	...	1	...	...	...	...	268
		R.	3	24	56	58	93	55	24	50	14	34	10	3	9	4	7	1	1	3	...	2	...	...	451
		N.	...	2	12	14	13	13	8	10	10	13	2	2	5	...	4	...	...	...	...	3	...	1	112
24.	Physique	F.	7	38	80	84	103	71	33	51	28	31	12	5	11	2	8	1	1	3	...	2	...	...	571
		U.	...	9	28	39	58	36	12	35	13	34	5	1	8	2	8	1	...	1	...	3	...	1	294
	Totals		7	47	108	123	161	107	45	86	41	65	17	6	19	4	16	2	1	4	...	5	...	1	865

Tables 25—30.

			Duration of alcoholism																						
			1–2	3–4	5–6	7–8	9–10	11–12	13–14	15–16	17–18	19–20	21–22	23–24	25–26	27–28	29–30	31–32	33–34	35–36	37–38	39–40	......	49–50	Totals
25.	Number of convictions	0–4	4	10	30	22	10	3	1	4	3	1	1	...	...	...	...	...	...	...	...	...	...	...	89
		5–9	1	20	28	25	27	12	3	6	5	5	2	...	...	...	...	...	...	...	...	...	...	...	134
		10–14	2	10	19	28	34	19	2	5	1	6	...	...	2	...	1	...	...	...	...	...	...	...	129
		15–19	...	4	20	20	27	20	6	8	5	5	1	...	...	...	1	...	...	...	...	1	...	...	118
		20–24	...	2	6	6	18	15	10	12	3	4	...	...	3	...	...	...	...	...	...	...	...	...	79
		25–29	...	1	3	12	17	8	4	13	6	3	1	...	...	...	1	1	...	...	...	...	...	...	70
		30–34	..	...	1	3	11	15	5	5	2	7	2	...	2	...	...	...	...	1	...	...	...	...	54
		35–39	...	...	1	2	8	4	3	13	3	6	2	2	2	...	1	1	...	...	...	...	...	...	48
		40–44	...	...	...	2	3	3	5	4	2	3	2	...	4	...	4	...	...	...	...	...	...	...	32
		45–49	...	...	...	1	5	2	1	3	3	9	...	1	3	2	1	...	...	...	...	...	...	...	31
		50–54	...	...	...	...	1	2	2	5	2	2	3	1	...	1	1	...	...	...	...	1	...	...	21
		55–59	...	...	...	...	...	2	...	...	...	3	1	...	1	1	...	...	...	1	...	1	...	...	10
		60–64	...	...	...	1	...	...	1	2	1	...	...	...	...	...	2	...	...	...	...	...	...	...	7
		65–69	...	...	...	...	...	1	...	3	1	3	...	...	...	...	...	...	...	1	...	1	...	...	10
		70–74	...	...	...	1	...	...	1	1	1	2	...	1	...	...	...	...	1	...	...	1	...	...	9
		75–79	...	...	...	...	...	...	...	1	...	2	...	...	...	...	...	...	...	...	...	...	...	...	3
		80–84	...	...	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	2
		85–89	...	...	...	...	...	...	...	...	1	...	...	...	...	...	2	...	...	...	...	...	...	...	3
		90–94	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	2
		95–99	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
		100–104	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		105–109	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		110–114	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	2
		115–119	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		120–124	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1
		125–129	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	..	1
		130–134	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
		135–139	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1
		140–144	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		145–149	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
		150–154	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
		155–159	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1
		160–164	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		165–169	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		170–174	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1
		175–179	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1
26.	Organic disease	N.	7	35	72	80	89	64	31	45	26	29	11	4	11	2	7	1	1	2	...	2	...	...	519
		G.D.	...	4	13	25	31	16	7	18	4	21	2	...	2	1	4	1	...	...	...	2	...	1	152
		H.D.	...	3	8	7	16	9	2	10	5	7	...	...	2	1	1	...	...	2	...	...	...	...	73
		S.	...	3	5	4	4	6	1	3	1	3	2	1	...	...	...	...	...	...	...	...	...	...	33
		O.	...	2	10	7	21	12	4	10	5	5	2	1	4	...	4	...	...	...	...	1	...	...	88
27.	Conduct	W.	4	35	73	90	121	81	31	52	28	41	8	4	10	3	7	2	1	2	...	4	...	...	597
		M.	2	5	23	21	20	17	7	23	6	15	7	1	6	1	6	...	...	2	...	1	...	1	164
		T.	..	5	7	9	13	3	5	6	4	5	1	1	3	...	1	...	...	...	...	...	...	...	63
		V.T.	1	2	5	3	7	6	2	5	3	4	1	...	...	...	2	...	...	...	...	...	...	...	41
28.	Civil status	S.	4	20	33	37	56	30	19	20	18	23	2	1	4	...	3	1	1	3	...	2	...	...	277
		M.W.	2	11	29	40	30	21	3	15	6	10	2	1	3	...	2	...	...	...	...	1	...	...	176
		M.A.	1	9	31	28	52	39	13	27	11	16	8	3	8	2	4	1	...	...	...	...	...	1	254
		W.	...	7	15	18	23	17	10	24	6	16	5	1	4	2	7	...	...	1	...	2	...	...	158
29.	Occupation	H.	2	13	28	34	32	18	4	12	5	9	1	...	1	...	1	...	...	...	...	...	...	...	160
		O.	4	21	53	63	88	49	27	47	21	45	10	4	15	4	14	2	1	3	...	4	...	1	476
		N.	1	13	27	26	41	40	14	27	15	11	6	2	3	...	1	...	...	1	...	1	...	...	229
30.	Morality	M.	4	28	64	67	77	47	13	35	19	28	5	1	8	2	11	2	1	1	...	4	...	1	418
		I.	3	19	44	56	84	60	32	51	22	37	12	5	11	2	5	...	...	3	...	1	...	...	447
	Totals		7	47	108	123	161	107	45	86	41	65	17	6	19	4	16	2	1	4	...	5	...	1	865

Tables 31—38.

Number of convictions

No.			0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89
31.	Mental condition	G.	58	93	57	30	21	7	11	7	6	7	5	2	1	2	2	...	1	...
		D.	29	38	69	84	51	49	32	33	19	18	14	4	5	8	3	1	...	1
		V.D.	2	3	...	3	6	11	8	7	7	5	1	4	...	...	3	1	1	2
		I.	...	...	3	1	1	3	3	1	...	1	1	...	1	...	1	1	...	...
32.	Education	S.	5	13	5	7	2	1	...	1	...	...	...	...	...	...	...	...	...	...
		R.W.	36	53	48	36	24	16	13	13	9	5	4	2	2	3	2	...	1	...
		R.	45	56	66	59	45	43	35	27	16	17	14	5	2	5	5	3	...	2
		N.	3	12	10	16	8	10	6	7	7	9	3	3	3	2	2	...	1	1
33.	Physique	F.	62	98	94	70	55	39	35	31	20	14	11	5	5	9	6	1	2	2
		U.	27	36	35	48	24	31	19	17	12	17	10	5	2	1	3	2	...	1
34.	Organic disease	N.	55	90	87	62	51	34	30	30	17	13	11	5	5	9	6	1	1	2
		G.D.	15	20	19	25	11	17	11	7	6	7	3	2	2	1	2	...	...	...
		H.D.	9	11	7	8	5	7	7	2	4	4	4	1	...	...	1	2	...	...
		S.	3	5	4	7	4	3	1	2	1	2	1	...	...	...	...	...	...	...
		O.	7	8	12	16	8	9	5	7	4	5	2	2	...	...	...	...	1	1
35.	Conduct	W.	70	111	102	84	55	37	30	29	19	19	13	6	4	4	6	1	...	1
		M.	17	16	17	18	14	17	17	10	9	5	5	4	1	5	1	...	1	1
		T.	2	4	7	7	7	11	4	5	3	4	3	...	...	...	1	1	1	1
		V.T.	...	3	3	9	3	5	3	4	1	3	...	...	2	1	1	1	...	...
36.	Civil status	S.	8	34	50	36	31	23	20	18	10	9	8	3	3	7	4	2	1	1
		M.W.	51	44	26	21	8	4	4	3	3	3	2	2	2	2	1	...	...	...
		M.A.	20	39	36	28	27	28	21	16	12	7	4	4	2	1	1	1	1	2
		W.	10	17	17	33	13	15	9	11	7	12	7	1	...	...	3	...	...	...
37.	Occupation	H.	51	40	23	19	5	4	8	1	2	1	1	1	1	2	1	...	...	...
		O.	28	71	68	72	50	37	30	35	20	21	14	5	1	7	6	2	1	2
		N.	10	23	38	27	24	29	16	12	10	9	6	4	5	1	2	1	1	1
38.	Morality	M.	80	87	61	52	25	26	21	18	13	10	6	3	3	4	5	1	1	1
		I.	9	47	68	66	54	44	33	30	19	21	15	7	4	6	4	2	1	2
	Totals		89	134	129	118	79	70	54	48	32	31	21	10	7	10	9	3	2	3

No.			90–94	95–99	100–104	105–109	110–114	115–119	120–124	125–129	130–134	135–139	140–144	145–149	150–154	155–159	160–164	165–169	170–174	175–179	Totals
31.	Mental condition	G.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	311
		D.	1	...	1	...	2	1	1	1	1	...	...	...	...	1	...	...	...	1	468
		V.D.	...	1	...	...	...	...	...	...	...	1	...	1	1	...	...	...	...	...	68
		I.	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18
32.	Education	S.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	34
		R.W.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	268
		R.	1	...	1	...	1	...	...	...	...	1	...	...	1	1	...	...	...	...	451
		N.	1	1	...	...	1	1	1	1	1	...	...	1	...	...	...	...	...	1	112
33.	Physique	F.	1	...	1	...	1	1	1	1	1	1	...	...	1	1	...	...	1	1	571
		U.	1	1	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	294
34.	Organic disease	N.	1	...	1	...	1	1	1	1	1	1	...	...	1	...	...	...	1	...	519
		G.D.	1	1	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	152
		H.D.	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	73
		S.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33
		O.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	88
35.	Conduct	W.	...	...	1	...	1	...	...	...	1	...	...	1	...	1	...	...	1	...	597
		M.	1	1	...	...	...	1	1	1	...	...	...	...	...	...	...	...	...	1	164
		T.	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	63
		V.T.	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	41
36.	Civil status	S.	2	...	1	...	1	1	...	1	1	...	...	...	...	1	...	...	...	1	277
		M.W.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	176
		M.A.	...	1	...	...	...	...	1	...	...	1	...	...	1	...	...	...	...	...	254
		W.	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	1	...	158
37.	Occupation	H.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	160
		O.	1	1	...	...	1	...	1	...	...	...	...	1	1	...	...	...	...	...	476
		N.	1	...	1	...	1	1	...	1	1	1	...	...	...	1	...	...	1	1	229
38.	Morality	M.	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	418
		I.	2	...	1	...	2	1	1	1	1	1	...	1	1	1	...	...	1	1	447
	Totals		2	1	1	...	2	1	1	1	1	1	...	1	1	1	...	...	1	1	865

Tables 39—66.

No.			Mental condition G.	D.	V.D.	I.	Total
39.	Education	S.	24	10	...	...	34
		R.W.	156	104	7	1	268
		R.	116	283	39	13	451
		N.	15	71	22	4	112
40.	Physique	F.	246	286	29	10	571
		U.	65	182	39	8	294
41.	Organic disease	N.	230	254	28	7	519
		G.D.	30	95	22	5	152
		H.D.	21	43	8	1	73
		S	6	20	3	4	33
		O.D.	24	56	7	1	88
42.	Conduct	W.	266	302	21	8	597
		M.	37	102	22	3	164
		T.	6	37	18	2	63
		V.T.	2	27	7	5	41
43.	Civil status	S.	89	151	28	9	277
		M.W.	77	89	8	2	176
		M.A.	87	143	20	4	254
		W.	58	85	12	3	158
44.	Occupation	H.	73	79	6	2	160
		O.	163	258	49	6	476
		N.	75	131	13	10	229
45.	Morality	M.	163	218	31	6	418
		I.	148	250	37	12	447
	Totals ..		311	468	68	18	865

No.			Education S.	R.W.	R.	N.	Total
46.	Physique	F.	25	194	292	60	571
		U.	9	74	159	52	294
47.	Organic disease	N.	24	179	261	55	519
		G.D.	6	40	79	27	152
		H.D.	...	20	48	5	73
		S.	...	9	20	4	33
		O.D.	4	20	43	21	88
48.	Conduct	W.	29	3	...	2	34
		M.	210	34	14	10	268
		T.	284	103	39	25	451
		V.T.	74	24	10	4	112
49.	Civil status	S.	10	74	152	41	277
		M.W.	9	43	98	26	176
		M.A.	9	96	124	25	254
		W.	6	55	77	20	158
50.	Occupation	H.	11	44	90	15	160
		O.	12	152	251	61	476
		N.	11	72	110	36	229
51.	Morality	M.	20	125	218	55	418
		I.	14	143	233	57	447
	Totals...		34	268	451	112	865

No.			Civil status S.	M.W.	M.A.	W.	Total
52.	Occupation	H.	...	137	23	...	160
		O.	168	35	147	126	476
		N.	109	4	84	32	229
53.	Morality	M.	58	167	114	79	418
		I.	219	9	140	79	447
	Totals...		277	176	254	158	865

No.			Organic disease N.	G.D.	H.D.	S.	O.D.	Total
54.	Conduct	W.	367	104	44	20	62	597
		M.	87	32	19	6	20	164
		T.	34	13	8	5	3	63
		V.T.	31	3	2	2	3	41
55.	Civil status	S.	192	34	20	10	21	277
		M.W.	111	31	16	3	15	176
		M.A.	143	42	22	12	35	254
		W.	73	45	15	8	17	158
56.	Occupation	H.	105	26	13	5	11	160
		O.	267	99	46	15	49	476
		N.	147	27	14	13	28	229
57.	Morality	M.	236	95	35	4	48	418
		I.	283	57	38	29	40	447
	Totals...		519	152	73	33	88	865

No.			Conduct W.	M.	T.	V.T.	Total
58.	Civil status	S.	183	48	30	16	277
		M.W.	133	28	9	6	176
		M.A.	167	61	13	13	254
		W.	114	27	11	6	158
59.	Occupation	H.	121	25	8	6	160
		O.	321	95	38	22	476
		N.	155	44	17	13	229
60.	Morality	M.	306	69	24	19	418
		I.	291	95	39	22	447
	Totals...		597	164	63	41	865

No.			Physique F.	U.	Total
61.	Organic disease	N.	519	...	519
		G.D.	...	152	152
		H.D.	20	53	73
		S.	16	17	33
		O.D.	16	72	88
62.	Conduct	W.	397	200	597
		M.	102	62	164
		T.	39	24	63
		V.T.	33	8	41
63.	Civil status	S.	208	69	277
		M.W.	118	58	176
		M.A.	168	86	254
		W.	77	81	158
64.	Occupation	H.	111	49	160
		O.	292	184	476
		N.	168	61	229
65.	Morality	M.	252	166	418
		I.	319	128	447
	Totals...		571	294	865

No.			Occupation H.	O.	N.	Total
66.	Morality	M.	147	242	29	418
		I.	13	234	200	447
	Totals...		160	476	229	865

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